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LACHNOSTERNA RECORDS IN WISCONSIN

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By means of a special fund granted by the Wisconsin legislature of 1913, experiments were carried out in 1914 and 1915 with regard to the serious white grub pests of the genus *Lachnosterna*, which have caused heavy losses during recent years. Several factors to be considered included: the determination of conditions; crops most seriously damaged with and without rotation; the species present and their habits, life-history, distribution and means of control.

It was decided that lantern traps be used as a means of collecting large numbers of the beetles for the purpose of determining the species to be found in the lower portion of the state, their attractiveness to lights with regard to sex, and the possibility of economic control in this manner. Some interesting information as to the number of species concerned and their relative abundance and distribution was secured. Some of the results are briefly outlined here.

The forty trap-lights used consisted of the Coleman gasoline arc lantern (Fig. 10), furnishing 300 to 400 candle power, set into large, galvanized refrigerator pans, five inches deep and about twenty-four inches in diameter. These pans were filled about two-thirds full of water, and one-half pint of kerosene was poured on the water and renewed when necessary. Perforated skimmers were used to remove the captured insects.

The five stations (Fig. 11) in the southern third of the state were located as follows: at Lancaster in the southwestern corner of the state, fifteen miles from the Mississippi river and twenty-five miles from the Illinois state line; at Dodgeville, thirty miles east and slightly north of Lancaster; at Madison, thirty-five miles east and north of Dodgeville; at Baraboo, forty miles northeast of Dodgeville and thirty-five miles northwest of Madison; and at Ripon, fifty miles northeast of Baraboo. With the exception of Madison, the stations were situated in a line running northeast from Lancaster, 120 miles to Ripon.

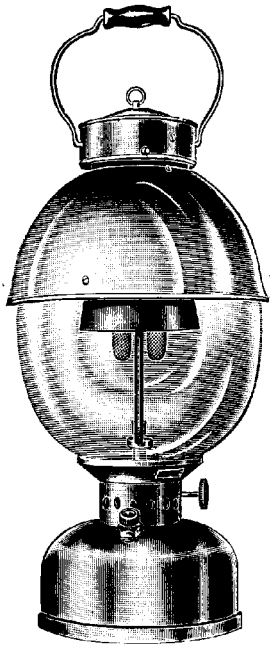


Fig. 10. Coleman Gasoline Arc Lantern (300–400 candle power) used in trapping experiments. [Cut furnished by the Coleman Lamp Co., Wichita, Kans.]

Generally speaking, Lancaster and Dodgeville are located similarly in a high rolling plateau region. Madison is on a lower level of black soil to the east of a hilly region. Baraboo is in a distinct region north of the Wisconsin river valley, featured by bold granite hills and higher plateaus. Ripon is in a lower rolling region of black soil. The latter two stations record slightly lower temperatures.

The forty light traps were operated from the time of the first flights in early May until late in June, and succeeded in catching an approximate total of one million thirty-six thousand four hundred (1,036,400) beetles.

Some striking results were obtained with regard to the distribution of species in this comparatively limited area, the optimum temperatures for flights, favorable location and arrangement of light traps. A mere summary of important results seems most desirable in this paper.

Temperature an Important Flight Factor

With 7 p. m. temperatures much below 66° Fahrenheit, flights were very small and almost ceased at 62°. Results show that 99.6

per cent of the entire catch of over 110,000 beetles at Baraboo and 99.1 per cent of the 14,500 at Ripon were made at 66° and upward. With higher temperatures, however, the volume of the flight did not always increase to a maximum at the highest degrees. Other weather conditions, such as cloudiness or moonlight, appeared to have less effect than is usually attributed to them.

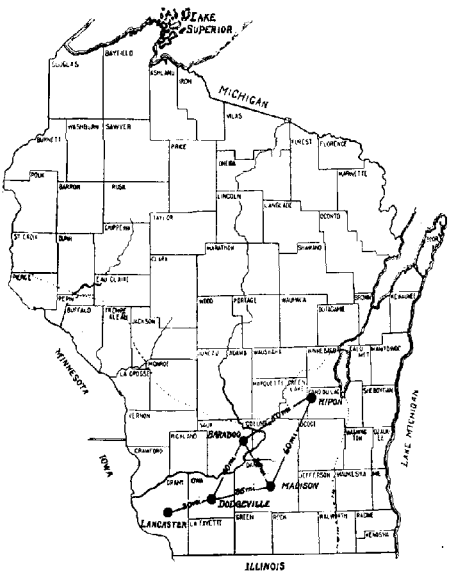


Fig. 11. Map of Wisconsin, showing trap-light stations and intervening distances. Dotted line bounds area of white grub damage.

The following table is a typical record from Baraboo:

Date	Weather Conditions	Temp. 8.00 p. m.	No. Beetles
May 14	Clear and calm	54°	0
May 15	Clear and calm	57°	0
May 16	Clear and calm	61°	135
May 17	Clear and calm	64°	154
May 18	Clear, light south wind	69°	1,250
May 19	Clear, light south wind	70°	1,902
May 20	Cloudy, light south wind	73°	3,156
May 21	Clear and calm	62°	155
May 26	Cloudy, warm south wind	80°	22,700

Distribution of Species

Species of Lachnosterna Captured at Trap Lights

A Comparative Table on a Basis of 10,000 Beetles

	Lancaster	30 mi.	Dodgeville	40 mi.	Madison	35 mi.	Baraboo	50 mi.	Ripon
No. beetles caught	440,000		271,600		?		110,285		14,519
No. beetles identified	12,246		16,268		10,839		16,847		14,519
L. fusca	9,669		9,328		3,903		934		1,290
L. rugosa	0		1		5,967		8,483		7,628
L. grandis	83		4		59		12		959
L. dubia	20		6		7		547		111
L. hirticula	25		225		0		4		4
L. gibbosa	47		251		4		2		0
L. ilicis	33		173		19		10		0
L. balia	52		1		0		1		0
L. tristis	29		0		0		0		2
L. nitida	15		4		7		1		2
L. implicita	19		0		0		0		1
L. marginalis	3		1		30		0		0
Other species (L. vehemens, nova, prunina, inversa, villifrons)	5		6		4		6		3

As will be seen by the accompanying table, there is a remarkable variation in distribution of species within a short distance of thirty or forty miles. Seventeen of the nineteen species known to occur in Wisconsin were taken in these traps. Mr. J. J. Davis adds *L. hornii* and *L. crenulata*[1], collected at Baraboo June 2, 1914, and a specimen of *L. crenulata* from Milwaukee County is also in the Milwaukee Museum. Not less than 10,839 specimens were determined for any station, ranging upward to 16,847—at Baraboo. The entire catch at Ripon has been determined specifically.[2]

In this comparative table computed on a basis of 10,000 beetles it is seen that *L. fusca* is more cosmopolitan than any other species and is dominant at Lancaster and Dodgeville. *L. rugosa* did not appear at Lancaster, the southwest station, but is dominant at the three northeasterly stations.

L. implicita, which was found most abundant by Dr. S. A. Forbes in Illinois in 1906, is rare at Lancaster and did not appear elsewhere except a lone specimen out of 14,519 determined from Ripon.

Only males of *L. gibbosa* and *L. nitida* were attracted to our lantern traps, and *L. tristis* also is but slightly attracted.

[1] After this paper was sent to the editor three specimens of *L. crenulata* were found in the trap collections from Baraboo.

[2] Much praise is due Mr. Neale F. Howard, now assistant at the Ohio State University, Mr. Stewart Chandler and Mr. T. T. Haack for their great care and painstaking efforts in determining all but a few of these specimens. The rarer species have been passed upon by Mr. J. J. Davis.

It will be noticed that several species almost disappear at the stations farther northeast, although *L. rugosa*, *dubia*, and *grandis* gain in numbers. An interesting record is the capture of *L. dubia* at Dodgeville, only previous to May 21, although the traps were run for another month. At Baraboo we took 92 per cent of the catch (377) of this species before the same date, thus indicating unusually early emergence.

Large Trap Pans Desirable

By surrounding the central pan, below the gas lantern, with six similar pans, it was found that 76.4 per cent of the beetles attracted to the light at Ripon, missed the central pan and were caught in the adjacent pans. It was found, also, that a pan placed on the side of the central pan toward the origin of flight caught twice as many beetles as a pan placed behind the light. The desirability of using as large a pan as possible is evident. There appeared to be no relative difference of sexes in the several pans.

An ordinary barn lantern used for the trap was found to be practically worthless when used less than 100 yards distant from one of the gasoline lights, but when used alone at some considerable distance caught a fair amount of beetles approximating 30 to 35 per cent of the efficiency of the gasoline light.

At the Lancaster station the direction of flight was always from the northwest toward the southeast. This phenomenon can possibly be explained by the fact that the flight seemed to be directed up a valley at the head of which was a fair-sized grove of trees, principally oak, ash and walnut. Another small valley diverging from the first was treeless and there the catch was very light, whereas in the adjoining small valley with trees available the catch was many times larger. Traps near the margin of woods or close to a fringe of trees were in all cases most successful and doubly efficient.

Economic Results

Any attempt to draw close conclusions on the beneficial results of the capture of these large numbers of beetles in 1914 would be undesirable and the resulting judgment inaccurate, owing to the nature of the season the following year. The heavy and frequent rains of 1915, accompanied by exceptionally low temperatures, resulted in retarded and weak crops.

Mr. W. A. Johnson, who was in immediate charge of the lanterns at Lancaster, states he feels certain, after constant observation throughout the summer of 1915, that the destruction of more than 440,000 beetles on his farm has served as considerable protection for his

crops. He reports that his corn was not noticeably injured, although a few grubs were present in the soil, while many of his neighbors' corn-fields were severely damaged. The only loss which he noted was on a far side of the farm where potatoes were injured somewhat. Too much emphasis must not be laid on this fairly accurate observation, because the grubs were destroyed in considerable numbers by diseases, aided by the damp weather. Had this summer been a normal season, we feel that a fair estimate of value of the experiments could have been made.

At Lancaster, where fifteen light traps were running, it is estimated that under ordinary farm conditions where help is comparatively cheap, the total cost of operation of the lights, exclusive of the initial expense of lights and pans, would not exceed twenty-five or thirty cents a day for the entire period. It is further evident with the knowledge that we have of the small flights of beetles in temperatures under 66° F., the cost of operation could be materially reduced by omitting the lights on nights of low temperature.

The Proportion of Sexes

Altogether our records show that the numbers of males caught greatly exceed the females, it is possible that some other reason may be attributed to this fact rather than the smaller degree of attractiveness to lights in the females. It may be possible that normally there are larger numbers of males than females.

It may be argued that the catch of such a small proportion of females would militate against the success of light traps in economic control, but again, if the beetles are polyandrous, as has been suggested by some entomologists, there may be an unexpected advantage in catching such a large number of the males.

Our records further show that with the more common species the females form a larger percentage of the catch in the earlier part of the season.

On the whole, this question of possible control of the white grub pest by trapping of the adult beetles must receive much further attention and consideration before any definite recommendations can be made.

Biological Experiments

The following experiments were undertaken in order to learn as much of the normal life of white grubs as possible. No investigations seem to have been made heretofore on the activities of any underground animals in their natural environment. For this reason the only control measures which have been suggested in the past are

partially empirical and partially based on very meagre information. This report is preliminary and the more promising lines of work will be continued. Attempts will also be made, where possible, to apply the results in a practical way.

In these experiments we tried to find out whether white grubs had daily or seasonal habits, such as those of cutworms, what was their relation to temperature and to moisture, what foods they would eat, and what part of the plants they preferred. Efforts were also made to control them by stomach poisons, contact insecticides, and repellents. No work was done with fumigants as this phase of the subject has been carefully studied by previous workers.

Two forms of cages were used, most of the work being done with ordinary flower pots. In working with this type of cage, which Davis has found to be most satisfactory for rearing the grubs, it is necessary to empty the flower pot at each examination. In all cases where continuous observations seemed desirable, glass cages (Fig. 12) were used in which the earth was placed between two vertical glass plates less than one-half inch apart. Opaque shields were used to keep out the light except at the moment the grubs were examined. It was found possible to regulate the distance between the glass plates so that any size of grub could be seen from at least one side at any time and still leave sufficient freedom for the grubs to move actively back and forth. When young corn plants were placed in the soil between the plates, the roots were readily eaten and usually completely destroyed.

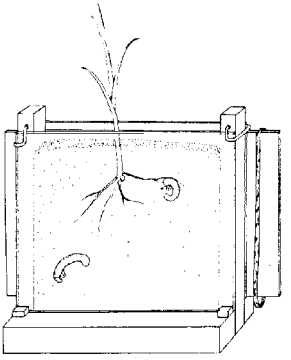


Fig. 12. Cage for Biological Studies of White Grubs.

The experiments may be divided into seven groups, all the important results so far secured being given below:

1. It was found that grubs have no daily migration, such as cutworms. They were never observed either eating or active late in the evening, early in the morning, or on cold days. Their movements reached the maximum during the heat of the day. There does not seem to be a vertical migration in relation to temperature changes, the larvæ in sod usually remaining close to the surface of the soil at all times but moving about and feeding only during warm weather.

The effective temperature of the soil seemed to be between 60° and 65° F., for when it was colder than this they did not move in the soil, did not feed, and scarcely made any resistance to handling.

2. Their food was found to consist, so far as observed, of the roots of plants only, or the fragments of these roots. They were never seen eating or manifesting any interest in any form of sweetened bran, dough or flour paste. In sprouting seed they uniformly ate the radicle and left the caulicle unharmed. This is also apparently true in the case of strawberries in the field, even when they have been planted so deeply as to cover the petioles of the leaves. In the case of grass it is more difficult to be certain of this habit.

3. Grubs were reared in flower pots containing moist garden soil with no apparent food from May 5 to July 18; the soil was then allowed to dry and on the 22d of October two larvæ were still found emaciated but alive and active in soil almost completely desiccated. The grubs then succeeded in living on minute root fragments and other humus in the soil for five and one-half months, of which the last three were passed in almost bone-dry surroundings. Under these circumstances, starvation methods of controlling them are proven impracticable.

4. Poison bran mash was found to be valueless against the grubs whether drilled into the earth above or below the larvæ or placed on its surface. This is, of course, due to the fact that they will not eat the bran.

5. In several experiments, including about forty grubs, grass roots were shaken free from earth, dipped in various arsenicals, and planted, in an attempt at poisoning the grubs. The use of sodium arsenite in this way, in the proportion of five pounds to fifty-four gallons of water, resulted in killing six larvæ out of a total of twenty-seven subject to poisoning, a mortality of 22.2 per cent in four days. No injury to the grass was observed. Attempts to accomplish the same results with lead arsenate in the proportion of five pounds of the paste to fifty gallons of water were unsuccessful. Corrosive sublimate used in the same way on a small corn plant caused a mortality of 50 per cent, but not in time to save the plant, as the roots were entirely eaten away by the grubs.

6. Kerosene emulsion and Black Leaf "40," in their ordinary strengths, did not affect the larvæ in the least when the soil was saturated with these solutions.

7. Professor H. T. Fernald a few years ago reported the successful use for two seasons of a repellant of tar on seed corn in preventing the attack of wireworms. Several repellants were tried in the experiments here being reported, but the only one which did not injure the

plant was creosote. Grubs apparently avoided the region where corn seed which had been dipped in creosote had been planted and did not attack the young corn which sprouted from it. These results, however, had not been anticipated and have not yet been followed up.

In connection with the insecticide experiments it should be stated that of the sixty-three larvæ which were reared in the flower pots, but on which no experiments were tried, ten died of bacterial or other diseases within forty days. This gives an average mortality in the check pots of 15.9 per cent for the six weeks.

In conclusion, it may be stated that the results in connection with temperature and the nature of the food supply seemed most significant. It is also of interest to note that white grubs are not immune from arsenical poisoning as wireworms have been said to be, and that there is a possibility that repellants will prove of some value in controlling them.

A PROGRESS REPORT ON WHITE GRUB INVESTIGATIONS[1]

By JOHN J. DAVIS, *U. S. Bureau of Entomology, West Lafayette, Indiana*

The white grub (*Lachnosterna*) investigation was begun at the Lafayette Station of the federal Bureau of Entomology in 1911 and has been one of the major problems of this station continuously since that date. .The report herewith presented is very brief and but an outline of some of the more important studies made by the writer or under his direction and is given at this time as a guide for those in the federal Bureau as well as station and state entomologists who are coöperating with us in this large problem and for others who are or may have occasion in the near future to take up this problem.

The plan and scope of our studies are comprehensive in the broadest sense, including not only life-histories and habits of the different species of *Lachnosterna* and means of control in this section of the United States but studies in the embryology, the distribution of species in all parts of the country in relation to soil, timber, farming methods and other environmental conditions, destructive broods of different species, systematics, etc., as well as thorough studies of the related genera, with especial reference to the economic importance and life-history of these related genera and means of distinguishing the larvæ of the different genera and of the different species in each genus. It is hoped eventually to have worked out the life-history and habits of every species of *Lachnosterna* and species of related genera for the various localities where each may occur.

[1] Published by permission of the Chief of the U. S. Bureau of Entomology.

The studies on the habits and life-histories have been conducted both in the field and in the laboratory. For instance, most of the studies to determine the habits of beetles, their food habits, etc., and the habits, etc., of the grubs have been made in the field with extensive observations and feeding experiments in confinement to corroborate our field observations. On the other hand, detailed studies of the various stages of the life cycle, the total life cycle, and the like, were conducted largely in breeding cages approximating as nearly as possible natural conditions. A discussion of the different cages used has already been given in this journal.[1]

Life-history Investigations

In this paper we will undertake to show only the more general conclusions and those which have a definite bearing on the economic phase of the subject. To date eighteen species of *Lachnosterna* have been reared from egg to adult and there are at least half as many more, the life cycles of which we are reasonably certain although it will be another year before we will have actually bred adults from eggs. The accompanying table will give data relative to the grosser points in the life cycle of the species studied at Lafayette. It will be seen from this that one species—*Lachnosterna tristis*—invariably has a two-year cycle in the latitude of Lafayette while eleven species, namely *L. arcuata, fusca, vehemens, rugosa, ilicis, grandis, fraterna, hirticula, inversa, bipartita* and *congrua,* invariably have a three-year cycle according to our experiments. Two species, *L. crenulata* and *L. crassissima,* have a three-year life cycle as a rule but our experiments show that it may be extended in the latitude of Lafayette to four years, and several other species, *L. gibbosa, burmeisteri* and *implicita,* usually have a three-year cycle but in some cases it may be cut to two years. However, all of the *Lachnosterna* of economic importance in this latitude have a three-year cycle.

Latitude naturally has a great influence on the length of the life cycle of the same species. For instance, *L. grandis* has a life cycle of three years in the latitude of Lafayette but at Trout Lake in the northern end of Wisconsin, it undoubtedly has a four-year life cycle. We now have cages at this point started in 1914 and 1915 and the small size of the grubs this summer in cages started in 1914 is evidence enough to show that the grubs cannot mature in less than four years. Further in 1911 the beetles (mostly *L. grandis* with a few *L. dubia*) were very abundant and in 1912 and 1913 the grubs were unusually injurious to seedling conifers. In 1915 the beetles were again very abundant. Furthermore, the combined seasonal temperatures for

[1] Jour. Econ. Ent., Vol. 8, No. 1, 1915, p. 135–139, 3 pls.

Trout Lake for four years approximate the combined temperatures at Lafayette for three years. It is not improbable that we will find the length of the life cycle of *L. ulkei*, which is the southern analogue of *L. grandis*, to be but two years at Auburn, Alabama, where we have experiments started in collaboration with Dr. W. E. Hinds. From our present data it appears that the more important economic species in the southern states will have a two-year cycle. It is easy to understand why a species should have a three-year life cycle in the latitude of Indiana and a four-year cycle in northern Wisconsin, where the season is so short, and, on the other hand, why the same species, in the southern states where the growing season is much longer, should require but two years to complete its growth. It is, however, puzzling to find that the same species in the same cage may complete its cycle in two years in one case but require three years in another.

We have already established life-history cages in coöperation with various entomologists in different parts of the country and it is hoped that eventually we can have cages established in every state in the Union. In 1914 and 1915 we started a number of cages at Trout Lake, Wisconsin, in coöperation with the Wisconsin State Board of Forestry and Mr. W. D. Barnard in charge of the state nurseries at that point. The past spring we established cages at Auburn, Alabama, in coöperation with Dr. W. E. Hinds; at College Station, Texas, in coöperation first with Prof. Wilmon Newell and at the present with Prof. F. B. Paddock; and at Victoria, Texas, in coöperation with Mr. J. D. Mitchell, through the courtesy of Dr. W. D. Hunter. Life cycle cages have also been established at two stations of this division, namely at the Greenwood, Miss., station in charge of Mr. C. F. Turner and at Columbia, S. C., in charge of Mr. Philip Luginbill.

Briefly the life-history of the economic species of *Lachnosterna* in our latitude is as follows: The eggs are laid in the ground, most often in ground covered with vegetation such as blue grass, timothy and small grain, in balls of earth (Plate 14, fig. e), one egg in a cavity slightly larger than the egg, in the center of the earthen ball which is held loosely intact by a glutinous fluid secreted by the female. Individual females lay between 50 and 100 eggs or even more and our averages from many records in confinement, which probably do not offer ideal conditions, are more than 50 per female. The grubs hatching from these eggs several weeks later feed on tender rootlets and decaying vegetation in the ground until fall when they go deeper into the soil, forming a small earthern cell in which they pass the winter. They return to near the surface early in May of the following spring and it is this season that the grubs are most active feeding. The grubs discontinue feeding about the first of October of the second year, going

down into the soil where they again prepare an earthen cell to pass the second winter. Reappearing to near the surface in the spring of the third year they are actively feeding and may do some damage but usually by June 1 they are full grown, prepare an earthen cell and change to pupæ in July, having passed the two weeks or so previous to pupation in a semi-dormant stage which we may call the prepupal stage (Plate 14, fig. f). Remaining in the pupal stage three to four weeks, the adults issue and remain in the pupal cell through the following winter, appearing above the ground the last of April or first of May. In this brood there is really but one season where injury may be severe but in northern Wisconsin where the life cycle is four years, injury occurs throughout the two seasons following the year the eggs are laid. As stated above, the larvæ pupate during the summer or early fall in the case of the species of importance in the latitude of Indiana. However, in southern Indiana and farther south, we have a number of species which pupate in the spring, and appear above ground as beetles the same season, examples of such species being *L. burmeisteri*, *L.* n. sp. (*ephilida* group), *L. quercus*, *L. antennata* and *L. gracilis*. These species, like beetles of the genus *Cyclocephala*, do not make their appearance until the latter part of June or July. No doubt we will find that all of the *Lachnosterna* which appear comparatively late in the season in southern states, likewise pupate in the spring.

Comparison with Related Genera

It will be interesting here to briefly note the life-history of species belonging to related genera. *Ligyrus gibbosus* and *L. relictus* have a one-year life cycle, the beetles pupating and appearing above ground in fall and reëntering the ground to pass the winter, not laying eggs until the following spring. The beetles are present at lights almost the season through, due to the excessive overlapping of broods. The grubs feed on manure and other decaying matter but the beetle of *L. gibbosus* feeds on the roots of various weeds such as *Amaranthus* and *Helianthus* and not infrequently noticeably damages crops of sunflowers. An interesting habit of the *Ligyrus* beetles is that they copulate under ground. *Cyclocephala immaculata* is frequently found in compost heaps and in cultivated fields, and may obtain its full growth on decaying matter alone or may become a serious field pest, damaging crops similar to those attacked by *Lachnosterna* grubs. It has a one-year cycle but, like certain of the *Lachnosterna*, pupates in the spring and appears above the ground the latter part of June and during July. The beetle seems to feed only on decaying matter and does not feed on foliage as do the *Lachnosternas*. *Cotinis* (= *Allorhina*) *nitida* and the *Euphorias* likewise have a one-year cycle, the

former pupating in spring and appearing about the same time the *Cyclocephalas* are out, and the *Euphorias* maturing in fall and appearing above ground quite early in spring. The grubs of these two genera are interesting because they crawl on their backs and their normal food is decaying matter, particularly animal manures. The habits of the beetles likewise differ from those already discussed in that they fly during the day. All of the *Anomalas* which we have studied have a one-year life cycle, maturing in the fall and appearing above ground the following spring. Our observations indicate that the grubs feed on living rootlets but apparently they are never sufficiently abundant to noticeably damage crops although they may at any time prove important crop pests. In the beetle stage certain species feed on tender foliage and flowers at night while others are active during the day. The grubs of *Cotalpa lanigera* rank close to those of *Lachnosterna* in economic importance in some sections. In the "thumb district" of Michigan and along the lake in the vicinity of Holland, Michigan, these grubs are destructive to raspberry bushes, strawberries, corn, grass, etc. We have not yet completed our life-history studies of this species but the grubs in our cages started in 1914 were very small when examined this fall (1915) and it will take four years and possibly five years to complete the life cycle. *Polyphylla* grubs are more nearly like *Cotalpa* grubs in their habits and life-history. Grubs which proved to be those of *P. variolosa* were shown us by Dr. T. J. Headlee who reported them as destructive to crops in southern New Jersey and a supply of the grubs received from the farmer reporting the trouble showed many sizes, indicating a four- or five-year cycle for this species. *Phytalis* and *Listochelus*, species of which genera belong to the southern fauna, have similar habits and resemble the *Lachnosterna* grub but have not yet been studied enough by us to make generalizations.

So many have written for information to distinguish the different white grubs that it seems pertinent at this point to mention some of the more conspicuous characters to distinguish the grubs of *Lachnosterna* from those of related genera.

The *Lachnosterna* grub is white or cream white, the dark contents of the intestinal tract being plainly visible through the skin of the last few abdominal segments. The head is light tan in color, smooth and shiny and the body is covered with reddish brown hairs, those on the dorsum of the folds or ridges being short and more thickly placed. The ventral surface of the anal segment, which shows the most prominent character, bears a triangular patch of brownish hairs which are hooked at the tip, with an intermixing, especially at the borders of the patch, of fine, long hairs, and with a median longitudinal double row

of coarse hairs or spines inclined more or less inwardly. These rows may be straight and parallel or more or less curved; short or long; and the spines in the rows may be sparsely or closely placed according to species. The anal slit is in the form of an obtuse angle.

Grubs of other genera which resemble the *Lachnosterna* grubs by having the two rows of spines on the underside of the last abdominal segment are *Anomala, Phytalis, Listochelus, Polyphylla, Euphoria,* and *Cotinis* (=*Allorhina*).

The living larvæ of *Euphoria* and *Cotinis* are at once separable because of their dorsal locomotion. The relatively small head which is finely reticulated, short legs, the transverse anal slit, two rows of unusually stout spines on the ventral surface of the anal segment and the straight hairs and spines on the same segment at once separate grubs of these genera from grubs of *Lachnosterna*. *Euphoria* grubs differ from those of *Cotinis* by their smaller size; the spines of the two median longitudinal rows on the anal segment are directed inwardly and are not so thick or stout, and the ventral surface of the anal segment is not uniformly clothed with hairs, there being bare spaces not to be found in *Cotinis*.

Polyphylla grubs are noticeably larger than those of *Lachnosterna*, when mature, the head is darker, and has a slight roughened reticulation. The two rows of stout spines, about ten spines in each row, on the under surface of the anal segment are short, being about a third the length of the segment and the upper surface of the anal segment is thickly covered with fine recumbent hairs. The anal slit is obtuse.

The grubs of *Anomala, Listochelus* and *Phytalis* are very close to those of *Lachnosterna* and we are at present unable to satisfactorily distinguish between grubs of these four genera except by direct comparison but no doubt substantial characters will be found when we obtain a sufficient number of grubs of the first three mentioned genera.

Grubs of such common species as *Trichius piger, Cotalpa lanigera, Ligyrus relictus, L. gibbosus, Osmoderma eremicola, Cyclocephala* spp. *Dyscinetus trachypygus* and *Stratægus antæus* are sometimes mistaken for grubs of the genus *Lachnosterna* but may at once be separated by the absence of the two rows of spines on the ventral surface of the anal segment and all of these species have a transverse anal slit.

Cyclocephala and *Cotalpa* are the most likely to be confused because they are found in fields with *Lachnosterna* grubs and attack the same crops. *Cyclocephala* grubs have a rather smooth light brown colored head which is inconspicuously reticulated. The spines on the underside of the anal segment are sparsely and uniformly placed, moderately long, and hooked. *Cotalpa* grubs have a brownish or tan colored head which is very slightly and noticeably reticulated and the under surface

of the anal segment bears rather thickly placed hooked spines, intermixed with a few long hairs. The dorsal surface of the anal segment is smooth in the middle, the sides and tip with a mixture of long and short, moderately erect hairs.

The grubs of *Ligyrus gibbosus* agree closely with those of *Cyclocephala* but the reticulation of the head is slightly more roughened, and the hairs or spines on the ventral surface of the anal segment are remarkably short, they are not hooked, and are more closely placed.

Ligyrus relictus is a more robust grub, the posterior abdominal segments being much enlarged and giving the grub a characteristic appearance. The head is small, dark brown and its surface reticulate. The ventral surface of the anal segment bears a patch of sparsely and irregularly placed short spines intermixed with a few longer hairs, and the dorsal surface of this segment bears only a few short spines and hairs.

The grubs of *Osmoderma eremicola* have a moderately light brown head and the mandibles and head at the base of mandibles are jet black. The ventral surface of the anal segment is covered with heavy spines, intermixed at the sides and extremities with longer hairs. The upper surface of this segment bears moderately short, uniformly placed, recumbent hairs.

Strategus antæus grubs are at once distinguished from other grubs mentioned above by the dark reddish brown head which is uniformly punctured with rather deep pits. The under surface of the last abdominal segment bears many spines which are slightly inclined caudad, the border of the patch of spines intermixed with longer hairs and the upper surface of same segment with moderately sparsely placed recumbent hairs.

Trichius piger grubs are small and have a pale brown head with an inconspicuous reticulation. The dorsal and ventral surfaces of the anal segment bear an irregular scattering of short spines and rather long hairs.

Dyscinetus trachypygus has a dark brown head which is inconspicuously reticulate and covered with irregularly placed fine punctures, in this respect differing from all species mentioned above, excepting *Strategus*, the head of which is much more coarsely punctate and the species is much larger. The ventral surface of the anal segment bears a patch of hooked spines and the upper surface of the same segment is covered, excepting along the longitudinal median line, with fine hairs, those at the tip being shorter, stouter and more spine-like.

Field Observations

The distribution of the many species is being worked out as rapidly as the collections being received will permit. We have records of

over 300,000 determined *Lachnosterna* beetles but there are many localities where scarcely any records are represented in our collections and many more collections, especially from southern states and from various sections of the other states, must be made before we can come to definite and satisfactory conclusions for the country as a whole. Any one who can collect beetles at trees or lights are urged to so notify us that we may offer all assistance possible. Our records, especially where continuous collections have been made, are very interesting, showing some species to occur at certain elevations, others where certain soil conditions exist, while still others are present only where foliage of a particular tree is available. Certain species such as *tristis, hirticula, fraterna*, etc., feed largely on hickory and oak, while others, usually beetles of the *fusca* group, prefer ash, and others, such as *gibbosa*, are general feeders. *Lachnosterna vehemens* is found at Lafayette almost exclusively in the bottom land area along the Wabash river and although supposed to be a comparatively rare species it is the predominant species at Elk Point, South Dakota, as found by Mr. C. N. Ainslie and the writer, in the fertile bottom land between the Missouri and Sioux rivers. Where we have found it behind the plow or in our beetle collections, it has been where the land is low, usually the bottom land along a river. Soil conditions also influence the abundance of certain species. While it is a well known fact that most species prefer a "timber soil," usually a clay loam soil, others have a decidedly different preference, for we find *L. prunina* invariably where the soil is sandy.

The time and length of the period of flight for the different species of *Lachnosterna* varies considerably. For instance, at Lafayette, *gibbosa* is one of the first to make its appearance in spring, and the last to disappear, and while such species as *arcuata* and *fusca* appear equally early they disappear more rapidly towards the latter half of June. Most of the species appear within a few days after the first flight of beetles but the delayed appearance of some species, such as *implicita, crenulata* and *ilicis*, is very pronounced, for instance, *implicita* seldom makes its appearance until the middle of May and disappears considerably earlier than most species. On the other hand, *tristis* is one of the first species to be found but by the first of June it has become a very rare species at both lights and trees. In the latitude of Lafayette, beetles first appear the latter part of April or first of May, usually the former, and reach a maximum abundance near or a little after the middle of May, gradually diminishing in numbers thereafter until July 1, after which date only straggling individuals are to be found. In southern Indiana and farther south, certain species, such as *L. ephilida, burmeisteri, quercus, gracilis*, etc.,

do not normally make their appearance until late June, occurring throughout the month of July and into August. From these notes it will be noticed that certain species are active above ground two months or more, while others disappear after three or four weeks. The longer period of existence is due to a longer period of life, and not to a succession of beetles, for in our cages where individual pairs were confined the length of life of the beetles coincided with the occurrence of the same species out-of-doors.

It is interesting to note the predominant species in different localities where grubs are of considerable economic importance. In the west—Utah, Idaho and Montana—the *Lachnosternas* are beginning to make their appearance as pests of importance and here the species involved is *L. dubia*. In the southeastern corner of South Dakota, the grubs have become very serious pests and here *L. vehemens* predominates. In northeastern Iowa, southwestern Wisconsin and northwestern Illinois, a center of a very heavy infestation and in an unglaciated region, we have *L. fusca* as the predominant species. *L. rugosa* is the dominant species in south central Wisconsin, being confined to the glaciated portion of the state, while a little farther to the east, in the vicinity of Beayer Dam, *L. fusca* again becomes the prevalent one. In the state forest nurseries of Minnesota and Wisconsin, the former at Lake Itasca and the latter at the extreme north border of Wisconsin in Vilas County, considerable trouble has been experienced with white grubs and at both of these places *L. grandis* is the predominant species. In the southwestern part of Michigan in and about Kalamazoo County the 1914 brood was a destructive one and here the predominant species is *L. hirticula* although *fusca* is also a common species. South and east of this infested district, that is, south of Battle Creek, we have another occurrence of *hirticula* but of a different brood, the date for the next flight of beetles in this district being 1916. In the "thumb district" of Michigan and on south into Ohio the 1914 brood was very important and it is interesting to note that here again in the glaciated area *L. rugosa* is decidedly the predominant species, but going a little east into Ohio the species doing the damage are *hirticula* and *fusca*, the former being the more common, according to our observations, in the center of the infested area. Continuing eastward into Maryland, *hirticula* again appears as the important species while in the infested counties of New York *dubia* and *fusca* are the two common ones. Going south we find *congrua* and *crassissima* are injurious species in Missouri while in Kansas wheat is attacked by white grubs mostly of the species *lanceolata* and *crassissima*. In the central part of Texas (Travis County), a great deal of damage to corn, cotton, and grasslands by grubs of *L. torta* has been reported.

By far the most serious and widespread white grub outbreaks on record are those of 1912 and 1915, the beetles for these broods occurring in the years 1911 and 1914, respectively. The area of these infestations included southeastern South Dakota, northwestern and northeastern Iowa, southeastern Minnesota, southern Wisconsin, northern Illinois, the extreme northwestern corner of Indiana, southwestern Michigan as well as the eastern portion of that state from the "thumb district" south into Ohio; also many points in the northern third of Ohio, western Maryland, northwestern and northeastern Pennsylvania, southeastern New York, including Long Island, and Connecticut. A less serious outbreak occurred in most of the above mentioned territory in 1909, but that of 1912 was very severe while the 1915 infestation was even more general and severe to cultivated crops, showing a gradual increase in the abundance of grubs and in the area infested. Although the grubs were more abundant and showed greater damage to cultivated crops in 1915, the grass crops were noticeably less injured, owing to the excessive rains throughout the summer. It was not an uncommon sight to see thirty- or forty-acre fields of corn totally destroyed and more often than otherwise the corn fields in the infested districts were 50 per cent destroyed. The accompanying photographs (Pl. 15) give a fair idea of the appearance of the infested fields in Wisconsin, Illinois and Iowa, although they do not impress one with the great amount of damage actually caused by the grubs. The various natural enemies now seem to be making headway in controlling the grubs and the crest of this destructive brood has probably been reached but it will be many years before the brood again becomes normal unless some unforeseen calamity overtakes it.

In 1911 the beetles were extremely abundant and stripped the timber of its foliage according to reports and during the latter part of May and the first of June in 1914 we made a trip across the northern end of Illinois, northeastern Iowa, southern Wisconsin as far north as Baraboo, thence east to Milwaukee, and through parts of Michigan, and everywhere, excepting in eastern Wisconsin, the timber, which consisted chiefly of oak and hickory, was completely stripped of its foliage. Only red oak, the maples, conifers and fruit trees were left with an appreciable amount of foliage, and the accompanying photographs (Pl. 16) illustrate the degree of defoliation which we found in the infested localities. To further illustrate—the beetles were so abundant that the dead ones accumulating beneath the lights had to be swept away each morning to prevent or at least modify the terrible stench which they produced. At one small town in Wisconsin the beetles accumulating beneath the ten arc lights of the town were hauled away each morning for a period of ten days or two weeks, by the wagon load.

Natural Enemies

Insect Enemies of Grubs.—Of the several insect enemies of white grubs, the *Tiphias* and *Asilids* are the most effective checks, according to our observations. In the genus *Tiphia* are several species attacking grubs, and of these we have worked out the life-history of two, neither of which has yet been specifically determined. Both have a one-year life cycle, passing the winter as larvæ within the cocoons, are parthenogenetic and paralyze the grub only temporarily, that is, only about long enough to deposit an egg. One of the species lays its egg on the dorsum of the thoracic segments of the grub while the other lays its egg on the underside of the abdominal segments.

Elis 5-cincta[1] and probably several other species of the genus are important enemies of the grub in some localities. The wasp has a one-year life cycle, it is not parthenogenetic according to our observations, and differs noticeably from *Tiphia* in that it paralyzes the grub completely, a paralyzed grub never coming back to active life although it remains inertly alive for several weeks to a month or more.

Three tachinids are parasitic on the grubs, all attacking it in a similar manner. These are *Microphthalma disjuncta*[2] which is common in the central western states, *M. pruinosa*[2] in the New England states, and *Ptilodexia tibialis*[2] in Texas.

Of the asilid enemies we have reared but one species, *Promachus vertebratus*, from larvæ actually observed feeding on grubs, and in certain parts of Wisconsin this is a prominent grub enemy. In the East the analogue of this species, according to Doctor Felt's observations, is *Promachus fitchii*. Both of these species appear to have a three-year life cycle, thus following the cycle of the grub. We have reared other asilids from grub infested fields but we have no absolute proof as to their predaceous habits excepting circumstantial evidence.

Several species of carabid beetles and their larvæ are predaceous on white grubs and the rôle they play in the control of grubs is probably greater than has heretofore been supposed.

Three insect enemies of minor importance have been previously reported, namely, *Pelecinus polyturator*, *Ophion bifoveolatum*, and *Sparnopolius fulvus*, thus bringing the total number of insect enemies of the grub to more than twelve species.

Insect Enemies of Beetles.—We have reared five dipterous parasites of the adult May-beetles, all of which have been previously reported as parasitic on May-beetles, and are *Pyrgota undata*, *P. valida*, *Cryptomeigenia theutis*,[2] *Eutrixa exile*,[2] and *Biomyia lachnosternæ*.[2]

[1] Gahan and Rohwer det.
[2] Walton det.

TABLE I. SUMMARY HISTORY OF CERTAIN SPECIES OF LACHNOSTERNA. LAFAYETTE, INDIANA

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
28	*L. arcuata*	12" flower pot	May 11, 1911	July 1913	Spring, 1914	3 yrs.	1	July 25, 1913	2 pupæ a 2 pupæ b	....	Pupæ preserved Aug. 12, 1913	.. ♀	
32	*L. arcuata*	12" flower pot	May 19, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 26, 1913	1 larva	Aug. 2, 1913	Aug. 29, 1913	♀	
53	*L. arcuata*	Bronze wire cloth 20" diam. 4 ft. deep	June 1, 1911	? Aug. 1913	Spring, 1914	3 yrs.	1	Aug. 6, 1913	3 pupæ a and b 3 pupæ c	....	2 pupæ preserved Aug. 28, 1913	♀	
102	*L. arcuata*	Pearl wire cloth 20" diam., 2½ ft. deep	May 7, 1912	July 1914	Spring, 1915	3 yrs.	9	July 22, 1914	10 pupæ a 10 pupæ b 10 pupæ c 10 pupæ d 10 pupæ e 10 pupæ f 10 pupæ g 10 pupæ h 10 pupæ j-k 1 larva i	.... July 26, 1914	Aug. 7, 1914 Aug. 17, 1914 Aug. 11, 1914 Aug. 7, 1914 Aug. 13, 1914 Aug. 15, 1914 Aug. 13, 1914 Aug. 14, 1914 2 pupæ preserved Aug. 22, 1914	♀ ♂ ♂ ♀ ♂ ♀ ♀ ♂ .. ♀	
119	*L. arcuata*	16" flower pot	May 25, 1912	July 1914	Spring, 1915	3 yrs.	2	July 13, 1914	3 pupæ a 3 pupæ b 3 pupæ c 3 pupæ d 2 larvæ e	.... Preserved July 18, 1914 Preserved July 18, 1914	Aug. 9, 1914 Aug. 9, 1914 1 pupa preserved	♀ ♂ ..	
127	*L. arcuata*	15" flower pot	June 2, 1912	June and July 1914	Spring, 1915	3 yrs.		July 16, 1914	8 pupæ a 8 pupæ b 8 pupæ c 8 pupæ d 8 pupæ e 8 pupæ f 8 pupæ g 8 pupæ x 5 larvæ b 5 larvæ i 5 larvæ j 5 larvæ k 5 larvæ l	.... July 17, 1914 July 22, 1914 July 20, 1914 July 18, 1914 July 19, 1914	Aug. 12, 1914 Aug. 9, 1914 Aug. 8, 1914 Aug. 12, 1914 Aug. 11, 1914 Aug. 12, 1914 Aug. 8, 1914 1 pupa preserved Aug. 13, 1914 Aug. 17, 1914 Aug. 17, 1914 Aug. 17, 1914 Aug. 14, 1914	♂ ♂ ♂ ♀ ♀ ♂ ♀ .. ♂ ♀ ♀ ♂ ♀	
202	*L. hirsuta*	20" galv. iron cage, 2½ ft. deep	May 1913	? Aug. 1915	Spring, 1916	3 yrs.	0	Aug. 9, 1915	1 pupa	.....	Pupa died before maturing	..	

211	*L. burmeisteri*	20" galv. iron cage, 2½ ft. deep	July 18, 1913	. . . 1915	Summer, 1915 Summer, 1916	2 yrs. 3 yrs.	11+	Aug. 5, 1915	4 adult ♂ and 2 larvæ found July 30, 1915 2 larvæ {a, b} 7 adults (1♂, 6♀) and 3 larvæ found Aug. 5, 1915 3 larvæ {a, b, c} Aug. 5	Preserved Passed winter 1915–16 as larva Passed winter of 1915–16 as larvæ			The larvæ passing the winter 1915–16 will undoubtedly pupate next spring and issue the same year hence we have an instance of the same species having a 2- and 3-year life cycle in the same cage
226	*L. burmeisteri*	—" flower pot	Aug. 19, 1913	.....	Summer, 1915 ? Summer, 1916	2 yrs. 3 yrs.	1+	Aug. 18, 1915	1 dead adult above ground which issued this spring 1 larva	..... Passing winter of 1915–16 as larva	.....		
204	*L. congrua*	20" galv. iron cage, 2½ ft. deep	May 22, 1913	Aug. 1915	Spring, 1916	3 yrs.	0	Aug. 6, 1915	1 pupa {a} 10 larvæ {b, c, d, e, f, g, h, i, j}	..... Aug. 23, 1915 Died Aug. 22 Aug. 22, 1915 Died Sept. 4 Died Aug. 19 Died Died Crushed and preserved	Preserved Preserved Preserved		
221	*L. crassissima*	15" flower pot	May 22, 1913	Jul.–Aug. 1915 ? ——— 1916	Spring, 1916 ? 1917	3 yrs. ? 4 yrs.	2+	July 19, 1915	11 larvæ {a, b, c, d, e, f, g, h, i, j, k}	Died Aug. 3, 1915 Died July 31, 1915 Aug. 7, 1915 Died Aug. 24, 1915 Died Preserved	Sept. 18, 1915 Died Sept. 21, 1915 Killed by fungus	♂ ♂ ♀ ♂	d and f passing winter as larvæ and it therefore appears that we have an instance of a variation in life cycle with the same species in the same cage
42	*L. crenulata*	12" flower pot	May 24, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 29, 1913	2 larvæ {a, b}	Aug. 5, 1913 Aug. 6, 1913	Aug. 29, 1913 1 pupa preserved, Aug. 17	♂ ...	

TABLE I—*Continued*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
50	*L. crenulata*	12″ flower pot	June 9, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 30, 1913	1 larva	Aug. 6, 1913	Aug. 30, 1913	♂	
126	*L. crenulata*	15″ flower pot	June 6, 1912	July 1914	Spring, 1915	3 yrs.	8	July 16, 1914	9 larvæ a b c d e f g h i	July 18, 1914 July 20, 1914 July 22, 1914 July 21, 1914 July 21, 1914 July 25, 1914 July 22, 1914 1 larva p'served July 19, 1914	Aug. 127, 1914 Aug. 14, 1914 Aug. 17, 1914 Aug. 14, 1914 Aug. 15, 1914 Aug. 20, 1914 Aug. 17, 1914 ..... Aug. 13, 1914	♀ ♀ ♂ ♂ ♀ ♀ .. ♀	
112	*L. crenulata*	20″ pearl wire cage, 2½ ft. deep	June 1, 1912	July 1915	Spring, 1916	4 yrs.	1	July 21, 1914	3 larvæ a b c	July 1915 Died Oct. 6, '14 Died July 24,'14	July 29, 1915	♂	
220	*L. crenulata*	15″ flower pot	May 21, 1913	? July 1915	Spring, 1916	3 yrs. 4 yrs.	1+	July 31, 1915	2 pupæ a b 2 larvæ c d	.... Passed winter 1915–16 as larvæ Preserved	Preserved Sept. 9, 1915	♀	This larva (c) will undoubtedly transform in 1916. Here we have an instance where the same species in the same cage may have a 3- or 4-year life cycle
104	*L. fraterna*	Pearl wire 20″ diam., 2½ ft. deep	May 19, 1912	July 1914	Spring, 1915	3 yrs.	1	July 22, 1914	1 pupa 1 larva	..... Died Aug. 7, '14	Aug. 15, 1914	♀ ..	
110	*L. fusca*	Pearl wire 20″ diam., 2½ ft. deep	May 28, 1912	July 1914	Spring, 1915	3 yrs.	1	July 18, 1914	1 pupa 3 larvæ a b c	..... July 21, 1914 July 20, 1914 Larva preserv'd	1 pupa preserved Aug. 19, 1914 Pupæ preserved	.. ♀ ..	
113	*L. fusca*	Pearl wire 20″ diam., 2½ ft. deep	June 2, 1912	July 1914	Spring, 1915	3 yrs.	1	July 21, 1914	1 pupa 3 larvæ a b c	..... Larva preserv'd July 25, 1914 Larva preserv'd	Aug. 19, 1914 D. before issuing	♂ ♂ ..	
213	*L. fusca*	15″ flower pot	May 13, 1913	July 1915	Spring, 1916	3 yrs.	1	July 31, 1915	2 pupæ a b	....	Died Aug. 8 Sept. 11, 1915	♀	

29	*L. gibbosa*	12" flower pot	May 12, 1911	July 1913	Spring, 1914	3 yrs.	3	July 25, 1913	3 pupæ (a, b, c)	.....	1 pupa preserved	♂	
									1 larva	July 30, 1913	Aug. 2, 1913 Aug. 6, 1913 Aug. 27, 1913	♂ ♂	
60	*L. gibbosa*	12" flower pot	June 1911	July 1913	Spring, 1914	3 yrs.	1	July 23, 1913	1 pupa	.....	Aug. 20, 1913	♂	
103	*L. gibbosa*	Pearl wire 20" diam., 2½ ft. deep	May 7, 1912	July 1914	Spring, 1915	3 yrs.	12	July 22, 1914	11 pupæ (a)	.....	Aug. 5, 1914	♂	
									(b)	.....	Aug. 7, 1914	♀	
									(c)	.....	1 pupa preserved	..	
									(d)	.....	1 pupa preserved	..	
									(e)	.....	Aug. 15, 1914	♂	
									(f)	.....	Aug. 7, 1914	♀	
									(g)	.....	Aug. 10, 1914	♂	
									(h)	.....	Aug. 6, 1914	♀	
									(i)	.....	Aug. 13, 1914	♀	
									(j)	.....	Aug. 13, 1914	♂	
									(k)	.....	Aug. 4, 1914	♀	
									4 larvæ (l)	1 larva preser'd	.....	..	
									(m)	July 28, 1914	Aug. 21, 1914	♀	
									(n)	July 25, 1914	Aug. 18, 1914	♂	
									(o)	July 27, 1914	Aug. 21, 1914	♂	
109	*L. gibbosa*	Pearl wire 20" diam., 2½ ft. deep	May 21, 1912	July 1914	Spring, 1915	3 yrs.	7	July 17, 1914	5 pupæ (a)	.....	Aug. 7, 1914	♂	
									(b)	.....	Aug. 10, 1914	♂	
									(e)	.....	Aug. 10, 1914	♂	
									(x, y)	.....	2 pupæ preserved	..	
									4 larvæ (d)	July 21, 1914	Aug. 14, 1914	♀	
									(e)	July 23, 1914	Aug. 20, 1914	♀	
									(f)	July 20, 1914	Aug. 15, 1914	♂	
									(g)	July 22?, 1914	Aug. 17, 1914	♀	
116	*L. gibbosa*	16" flower pot	May 15, 1912	July 1914	Spring, 1915	3 yrs.	4	July 14, 1914	1 pupa	.....	Preserved	..	
									7 larvæ (a)	Preserved	.....	..	
									(b)	July 20, 1914	Aug. 14, 1914	♂	
									(c)	July 18, 1914	Aug. 12, 1914	♀	
									(d)	July 16, 1914	Aug. 9, 1914	♂	
									(e)	July 23, 1914	D'd Aug. 28, 1914	♀	
									(f)	July 16, 1914	Aug. 9, 1914	♀	
									(g)	Preserved	.....	..	
133	*L. gibbosa*	15" flower pot	May 15, 1912	.....	Spring, 1914	2 yrs.		July 15, 1914	At least 3♂ and 3 ♀ *L. gibbosa* which issued the past spring and had died in the cage. Not only were the cast pupal skins found but also 35 recently hatched grubs, thus proving beyond doubt a 2-year life cycle in this instance				
205	*L. grandis*	20" galv. iron cage, 2½ ft. deep	June 1, 1913	July 1915	Spring, 1916	3 yrs.	1	Aug. 6, 1915	2 pupæ (a)	.....	Aug. 27, 1915	♀	
									(b)	.....	Pupa preserved	♀	
54	*L. hirticula*	20" brass cloth cage, 4 ft. deep	June 7, 1911	? July 1913	Spring, 1914	3 yrs.	0	Aug. 6, 1913	2 pupæ	.....	Both pupæ preserved		

TABLE I—*Continued*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
62	*L. hirticula*	Shallow 12" pot	June 1911	.....	Spring, 1914	3 yrs.	0	July 11, 1913	1 larva	In prepupal stage	Preserved		
107	*L. hirticula*	20" pearl wire cage, 2½ ft. deep	May 25, 1912	July 1914	Spring, 1915	3 yrs.	5	July 21, 1914	6 pupæ a	.....	Aug. 17, 1914	♂	
									b	.....	Died July 27	♂	
									c	.....	Aug. 12, 1914	♂	
									d	.....	Died Aug. 3	♂	
									e	.....	Aug. 19, 1914	♂	
									f	.....	Preserved	♂	
									2 larvæ g	July 22, 1914	Aug. 19, 1914	♀	
									h	July 25, 1914	Aug. 22, 1914	♀	
129	*L. hirticula*	15" flower pot	June 2, 1912	July 1914	Spring, 1915	3 yrs.	0	July 17, 1914	1 larva	July 22, 1914	Died in pupa stage	..	
41	*L. ilicis*	12" flower pot	May 23, 1911	? July 1913	Spring, 1914	3 yrs.	1	July 29, 1914	1 pupa	.....	Aug. 5, 1913	♂	
130	*L. ilicis*	15" flower pot	May 22, 1912	July 1914	Spring, 1915	3 yrs.	1	July 12, 1914	1 larva	July 26, 1914	Aug. 31, 1914	♀	
106	*L. implicita*	20" pearl wire cage, 2½ ft. deep	May 24, 1912	July 1914	Spring, 1915	3 yrs.	0	July 20, 1914	2 pupæ a	.....	Preserved	..	
									b	.....	Preserved	..	
									2 larvæ c	.....	Preserved	..	
									d	.....	Preserved	..	
128	*L. implicita*	15" flower pot	June 2, 1912	? 1913	Spring, ? 1914	? 2 yrs.	0	July 15, 1914	Found neither grubs, pupæ or adults but found 2 pupal skins and remains of beetles indicating strongly a 2-year life cycle in this instance				
122	*L. inversa*	15" flower pot	June 4, 1912	July 1914	Spring, 1915	3 yrs.	1	July 13, 1914	1 larva	July 17, 1914	Aug. 12, 1914	♂	
123	*L. inversa*	16" flower pot	May 9, 1913	? July 1915	Spring, 1916	3 yrs.	5	Aug. 2, 1915	11 pupæ a	.....	Died	♂	
									b	.....	Sept. 6, 1915	♂	
									c	.....	Died	♀	
									d	.....	Aug. 23, 1915	♀	
									e	.....	Aug. 23, 1915	♂	
									f	.....	Aug. 28, 1915	♂	
									g	.....	Aug. 25, 1915	♀	
									h, i, j	.....	Preserved	..	
200	*L. inversa*	20" galv. iron cage, 2½ ft. deep	May 13, 1913	? July 1915	Spring, 1916	3 yrs.	4	Aug. 9, 1915	8 pupæ a	.....	Aug. 26, 1915	♀	
									b	.....	Aug. 28, 1915	♀	
									c	.....	Aug. 28, 1915	♂	
									d	.....	Preserved	♀	
									e	.....	Aug. 24, 1915	♂	
									f, g, h	.....	No record Preserved	..	

207	*L. lanceolatis*	20″ galv. iron cage, 2½ ft. deep	June 23, 1913	.....	.....	2 yrs.	1	Aug. 6, 1915	1 ♀ adult	When examined Apr. 6, 1915, found one grub near surface which is preserved and when thoroughly examined Aug. 6, find one beetle above ground, indicating a 2- and possibly a 3-year life cycle in some cases		
55	*L. rugosa*	20″ tile, 4 ft. deep	June 7, 1911	? July 1913	Spring, 1914	3 yrs.	2	Aug. 4, 1913	6 pupæ a b c d, e, f	....	Aug. 31, 1913 ? Preserved Preserved	♀ ♂ .. ..
111	*L. rugosa*	20″ pearl wire cage, 2½ ft. deep	May 28, 1912	July 1914	Spring, 1915	3 yrs.	2	July 18, 1914	4 pupæ a b c d 1 larva e	.... Preserved	Aug. 15, 1914 Aug. 9, 1914 Preserved Preserved	♀ ♂ .. .. ..
117	*L. rugosa*	15″ flower pot	May 21, 1912	July 1914	Spring, 1915	3 yrs.	0	July 14, 1914	1 larva	July 20, 1914	Pupa matured but failed to issue	♀
125	*L. rugosa*	15″ flower pot	June 6, 1912	July 1914	Spring, 1915	3 yrs.	6	July 15, 1914	4 pupæ a b c d e 3 larvæ f g	.... July 17, 1914 July 17, 1914 Preserved	Aug. 6, 1914 Aug. 7, 1914 Aug. 6, 1914 ? Ad'lt, failed to iss'. Aug. 11, 1914	♀ ♂ ♀ ♂ ♀ ♂ ..
30	*L. tristis*	12″ flower pot	May 13, 1911	.....	Spring, 1913	2 yrs.	1	Sept. 23, 1913	1 adult	.....	.....	♀
31	*L. tristis*	12″ flower pot	May 17, 1911	.....	Spring, 1913	2 yrs.	2	Sept. 23, 1913	2 adults	.....	.....	♂ ♀
131	*L. tristis*	15″ flower pot	May 22, 1912	? July 1913	Spring, 1914	2 yrs.	0	Aug. 8, 1913	1 pupa	.....	Preserved	..
121	*L. schemens*	16″ flower pot	June 4, 1912	July 1914	Spring, 1915	3 yrs.	7	July 13, 1914	7 pupæ a b c d e f g 1 larva	.... July 14, 1914	Aug. 7, 1914 Aug. 10, 1914 Aug. 10, 1914 Aug. 8, 1914 Aug. 7, 1914 Aug. 7, 1914 Preserved Aug. 10, 1914	♀ ♂ ♂ ? ♂ ♀ .. ♀

TABLE I—*Concluded*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
132	*L. vehemens*	15″ flower pot	May 22, 1912	July 1914	Spring, 1915	3 yrs.	6	July 17, 1914	6 pupæ a	.....	Aug. 12, 1914	♀	
									b	.....	Aug. 10, 1914	♂	
									c	.....	Aug. 11, 1914	♂	
									d	.....	Aug. 11, 1914	♀	
									e	.....	Preserved	..	
									f	.....	Preserved	..	
									3 larvæ g	July 19, 1914	Aug. 17, 1914	♀	
									h	July 20, 1914	Aug. 18, 1914	♀	
									i	Preserved	.....	..	
215	*L. vehemens*	15″ flower pot	May 13, 1913	? July 1915	Spring, 1916	3 yrs.	7	Aug. 5, 1915	8 pupæ a	.....	Aug. 23, 1915	♂	
									b	.....	Aug. 23, 1915	♂	
									c	.....	Aug. 26, 1915	♂	
									d	.....	Aug. 21, 1915	♂	
									e	.....	Sept. 2, 1915	♀	
									f	.....	Aug. 31, 1915	♂	
									g	.....	Sept. 6, 1915	♀	
									h	.....	Preserved	..	

The last is the species referred to by Dr. Forbes as *Viviana* sp. on p. 475 of bulletin 116 of the Illinois Agricultural Experiment Station.

MISCELLANEOUS ENEMIES.—Spiders are quite predatory on beetles often catching them in their webs but not infrequently actually capturing the beetle as it feeds at night. Mites are very troublesome in cages where they attack grubs and occasionally we find them sufficiently numerous on grubs in the field to cause their death.

Animals such as skunks and opossums are well-known enemies of grubs and do their share towards holding them in check, while many birds, and especially crows and blackbirds, are equally well known for their fondness for white grubs.

DISEASES.—Four types of grub diseases are known, these being of fungus, bacterial, protozoan and nematode origin, respectively. Among the fungus diseases the best known are the *Cordyceps* because of the peculiar growth which they cause. The green muscardine fungus (*Metarrhizium anisopliæ*) is almost equally well known as an insect fungus disease and although it seems to have been successfully used artificially for the control of some insects, it has never proven satisfactory nor even given an indication of proving satisfactory against white grubs.

Of the several recognized bacterial diseases none have shown any indication of proving effective in the control of the white grub.

We have observed two outbreaks of a protozoan disease of white grubs which has apparently effectively controlled the grub in certain localities. It was first observed at Hoopeston, Illinois, by Mr. W. P. Flint and the writer (Oct. 1912) and later (Oct. 1915) by the writer at Belvidere, Illinois. In both cases the diseased grubs came to the surface or to near the surface of the ground where they died.

At Lancaster, Wisconsin, we found a number of fields in 1915 which were apparently cleared or at least practically cleared of grubs by a nematode "disease," an affection which seemed to be assisted greatly by the wet season.

METHODS OF CONTROL

UTILIZING FARM ANIMALS.—Hogs have been employed as a means of clearing fields of white grubs for many years and where they can conveniently be turned into an infested field this is the surest and quickest method that may be employed. When the infested field is being plowed, if before the grubs have gone deep into the ground or after the grubs have returned to near the surface in the spring, hogs should be allowed the run of the field. Likewise chickens and turkeys should be trained to follow the plow, harrow, and cultivator in fields located near the farm buildings. We have known of fifteen-acre

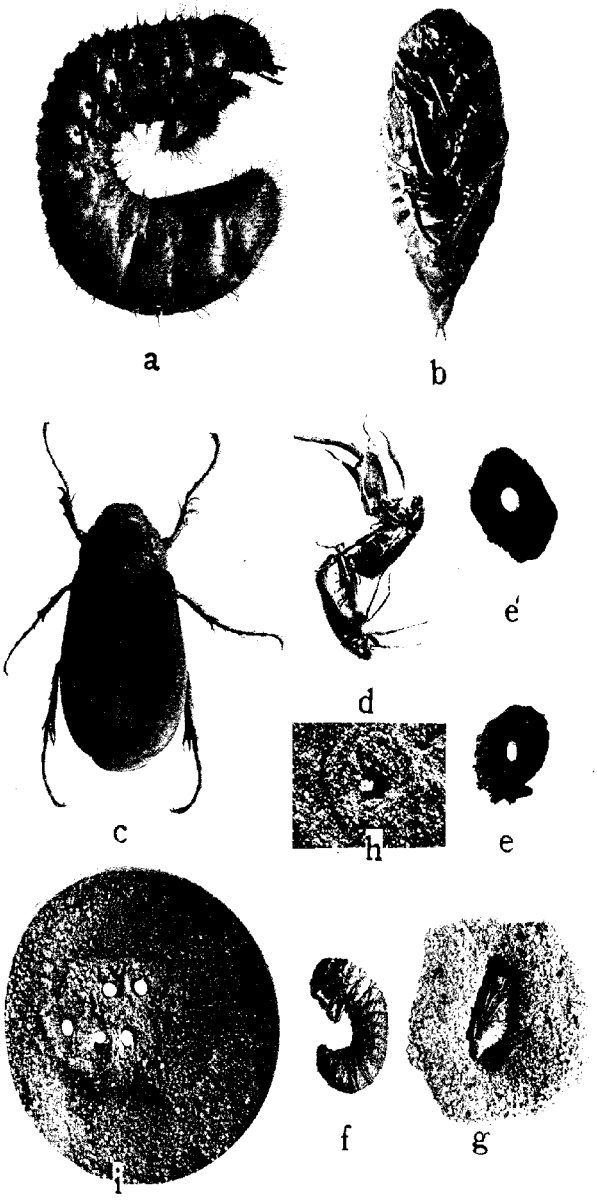
fields being cleared of a heavy infestation of grubs by permitting the chickens the run of the field during cultivation.

FALL PLOWING.—Plowing just previous to the time the grubs go deep into the ground to pass the winter will destroy many of them and should be practiced whenever possible but it should not be considered a panacea for the grubs. Fall plowing the year the grubs are changing to beetles, especially early fall plowing and the sooner after July 15 the better, is very effective in destroying the grubs as they are transforming to pupæ, the pupæ themselves and the recently issued beetles. If the cells containing prepupæ, pupæ and recently issued beetles are broken, the insect within will almost invariably be destroyed and it is therefore important to use a plow which will break up the soil as it is overturned, or if this is not possible the ground should be deeply disked after plowing in order to break up the soil. In 1916 early fall plowing will be especially helpful in the localities where grubs were so destructive in 1915 and where entire communities can follow this practice much benefit will result.

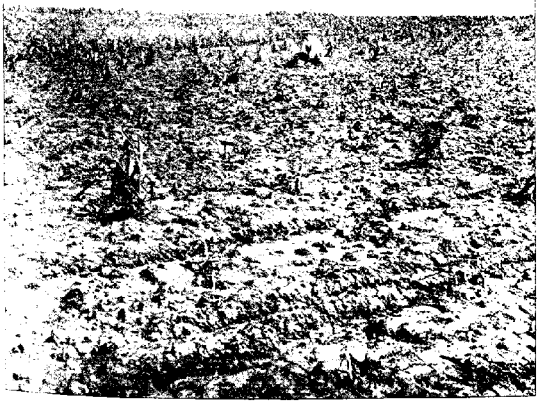
ROTATION OF CROPS.—A rotation to avoid grub injury is of greatest importance but it is essential that the farmer be acquainted with the life-history and habits of the insect in order to intelligently adopt a rotation which will not only be effective in preventing grub injury but which will be best suited to his conditions. We know the beetles prefer a ground covered with vegetation for the deposition of their eggs, hence, other conditions being equal, most of the eggs will be laid in timothy, blue grass, and small grain fields. Consequently, the year following a large flight of beetles, such ground should not be planted to the more susceptible crops such as corn and potatoes. On the other hand, land which was in corn or other wide-row crops and kept thoroughly cultivated during the flight of the beetles will ordinarily have few grubs and hence such land should be used the following year for the crops most susceptible to grub injury, that is for corn, potatoes, beans, etc. A rotation of oats, clover and corn has proven very satisfactory in some sections. Our observations indicate that ground with a heavy stand of pure clover when the beetles are flying will ordinarily contain few grubs since the beetles will not seek such land for egg-laying. Clover, if planted in the fall and allowed to make a good

EXPLANATION OF PLATE 14.

Plate 14. *a*, *Lachnosterna grandis* grub. *b*, *L. grandis* ♀ pupa. *c*, *L. prunina* ♂ adult. *d*, *L. gibbosa* in copula. *e*, *L. arcuata* egg recently laid; *é* fully swollen, *f*, *L.* sp. grub in prepupal stage. *g*, *L. gibbosa* pupa in pupal cell. *h*, *Diplotaxis* eggs, several eggs in a ball of earth in a single cavity. *i*, *Cotinis nitida* eggs, in individual cavities but many eggs in a single ball of earth; *a*, *b*, and *c* much enlarged, others about natural size.


a
b
c
d
e'
e
h
f
g
i

Corn field at Platteville, Wis., badly damaged by white grubs. Aug. 18, 1915



40-acre corn field at Froelich, Ia., destroyed by white grubs. Aug. 6, 1915

Timber patch (burr oak and hickory) at Platteville, Wis., defoliated by May-beetles. Shrubs at the base of trees and portion of boxelder tree at extreme left undefoliated. June 1, 1914.

Large cottonwood, an ash and several elm trees defoliated by May-beetles. An apple at extreme left untouched. Galena, Ill. May 13, 1914.

growth before the grubs are actively feeding the following summer, is a good crop to follow on grub-infested land. Likewise small grain crops are not greatly injured by grubs and should be used for grub-infested ground in preference to the more susceptible crops such as corn. Aside from the rotations mentioned above, it is desirable to so arrange the crops that the least amount of land will be in timothy and small grain the year the beetles are abundant, and the following year to plant corn or other susceptible crops in corn ground or ground which was kept thoroughly cultivated during the flight of the beetles the year before, and to plant small grain or clover on ground which was in these crops the previous year.

The farmer should plow land suspected of containing grubs previous to October 15 the fall following a big flight of beetles and select a crop for the following year according to the presence or absence of grubs.

MISCELLANEOUS DIRECTIONS.—The collection of the beetles by hand or by means of a trap lantern, or by spraying trees upon which they feed with an arsenical, has been employed in certain European countries and no doubt would prove of value in this country, but to be effective it is necessary that entire communities work together and adopt the measures.

Collecting the grubs behind the plow by hand, utilizing boys or cheap labor for this purpose, is of much value although similar results can be obtained by employing hogs or chickens as mentioned above.

FURTHER NOTES ON DIPRION SIMILE HARTIG

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

The writer has already called attention in the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 8, p. 379, June, 1915), to the occurrence of this European pine sawfly in Connecticut. That article will enable one to recognize the species, and also points out the possibility that it may prove a destructive pest in this country as it is in Europe. He now wishes to add a few data collected in the further study of this insect since the former article appeared in print.

Diprion simile is present in Connecticut not only at New Haven, but also at Derby, ten miles westward, at Hartford thirty-seven miles northward, and at New Canaan, about thirty miles, and Greenwich about fory-five miles westward. Greenwich and New Canaan are border towns adjoining New York state where it may be expected that this insect will soon appear.

As this sawfly was found to be present in five rather widely separated localities in Connecticut, it was probably too late for extermina-

tion, and therefore only control measures were put into effect. These consisted of a careful inspection in summer and collecting all larvæ found; thoroughly spraying with lead arsenate all trees infested; another careful inspection in late fall and early winter to gather all cocoons from the twigs.

The insectary records were kept by my assistant, Mr. M. P. Zappe, to whom I am indebted for some of the data included in this paper.

During 1915, two complete generations were reared and a number of males of the third generation emerged late in the fall. Possibly another year we may be able to obtain three complete broods, because on account of an accident some of the first second-brood larvæ died. The broods overlap and are rather irregular. Some of the over-wintering pupæ did not produce adults until after the first generation of larvæ had matured. If the needles became dry, as is sometimes the case with cut twigs, the eggs failed to hatch. Unfertilized eggs hatched, and the larvæ developed normally to the pupal stage, in which condition they are now passing the winter.

The average length of the larval stage appears to be about thirty and one-half days.

In Connecticut *Diprion simile* feeds upon the white pine, *Pinus strobus;* the Austrian pine, *P. laricio* var. *austriaca;* the Japanese or Bhotan pine, *P. excelsa;* the Scotch pine, *P. sylvestris;* the mugho pine, *P. montana; P. flexilis* and *P. densiflora.* All newly-hatched larvæ died when fed on Austrian pine, but after the first instar they were able to finish their subsequent development upon this food plant. Probably when in need of food this sawfly may attack almost any kind of pine and possibly other conifers.

There is some consolation in learning that *Diprion simile* is highly parasitized, and of the parasites which have been reared up to this time, all are native American species; I am indebted to Mr. S. A. Rohwer of the Bureau of Entomology for their identification. Of 152 over-wintering cocoons, 46, or about 31 per cent, were parasitized by the Chalcid fly *Pachyneuron* (*Dibrachys*) *nigrocyaneus* Norton. One specimen each of *Hemiteles utilis* Norton, and a species of *Cerambycobius* were obtained. Tachinid eggs are not uncommon upon the larvæ and *Exorista petiolata* Coquillett was reared from the cocoons.

APIARY INVESTIGATIONS IN MISSOURI

By L. Haseman, *Columbia, Mo.*

In the past few years the writer has felt the growing need and demand on the part of farmers and beekeepers for help along beekeeping lines. The state agricultural colleges for years have been teaching

better agricultural methods and the experiment stations have been investigating methods of increasing yields and maintaining soil fertility while the beekeepers have received comparatively little help. At least these have been the conditions in this state. In some cases the profits from bees have helped to send young men and women to the University, where they have found instruction in almost every subject except beekeeping.

Three years ago the first real instruction in beekeeping was given by this department. Along with the development of courses in beekeeping we have begun some investigations and are planning more extensive work for the future.

In Missouri it seems that beekeeping must inevitably resolve itself into farm beekeeping. Our natural, climatic and agricultural conditions all point in the direction of small apiaries if future beekeeping in Missouri is to thrive. We do not have conditions for successfully maintaining apiaries of hundreds of colonies in any one locality. If ten strong colonies of bees will save the honey flow in any locality why try to maintain an apiary of fifty colonies to accomplish the same end and eat up all the profits? Since these conditions prevail with us, we have planned, first of all, to "preach the gospel" of small apiaries, well located, with only strong vigorous colonies of bees. Our first investigations are also planned for like conditions. Along with the preparation of our first report on "Farm Beekeeping," now in press, we have been studying economical methods of securing a few strong colonies as a start and the necessary equipment so as to place beekeeping within the reach of every family. A few strong, well cared for colonies of bees on every Missouri farm is the remote goal toward which we are working.

The simple methods of dividing and forming nuclei and the methods of queen rearing and requeening are being studied with a view of enabling any farmer to build up his apiary. We have demonstrated in a modest way in our department apiary that without the expenditure of much money, any one, who is willing to study and work, can build up a small apiary and secure both profits and pleasure from it. Our colonies are used both for class work and for demonstration purposes at fairs and yet in the past three unfavorable seasons we have built up an apiary of from two to seven excellent stands, and have gotten surplus honey every year, even as much as sixty pounds from one of the stronger stands one season. These smaller and simpler things in beekeeping are receiving our special attention now for we realize that to develop successful farm beekeeping in the state we must first reach the beekeepers with simple, practical farm methods. The larger problems of out-apiaries, wintering in cellars, engine extracting outfits and the like have no place in our present work.

We find, according to Dr. Phillips of the Bureau of Entomology of the U. S. Department of Agriculture, that next to Texas, Missouri is in the lead as regards the number of colonies of bees. In round numbers we have 40,000 farmers and others keeping bees with a total of 203,569 colonies. It is with the problems of these forty thousand beekeepers, who have on an average five colonies each, that we are now vitally concerned in order to help make, if possible, not 25 per cent but 100 per cent of the total number of colonies self-supporting and profitable.

Of all the important subjects confronting us the one which seems most vital and in need of first attention is the whole question of bee pasturage. Our honey flows are usually very short and some seasons dry weather shuts them off suddenly when they may not open again until late in the fall. These are the conditions which make beekeeping such a gamble; especially in case of large apiaries. The following questions are a few which we hope to solve within the next few years: How many colonies of bees can one profitably keep under different surroundings in this state? What are our important honey plants? What agricultural crops can we hope to use for bee pasturage? How can we make use of much of our waste lands for beekeeping? Is it possible to keep a few colonies of bees with profit in spite of unfavorable seasons as regards honey flow? Some of these questions have already been touched upon but further investigation of them is necessary. Some of these investigations will be carried on in coöperation with our more progressive and observing beekeepers while the more technical studies will be undertaken in the department apiary on the college farm at Columbia.

Rocky hillsides, unfit even for blue grass pasture, will be worked over and used for growing different plants of possible value as bee pasture. Thousands of acres of Missouri hills now lie idle, much of which may under proper treatment serve as profitable bee pasture. Along with the investigations of waste lands for bee pasture, tillable plots will be used for growing cultivated and wild plants which show promise of proving of value as bee pasture. Our principal honey crop, white clover, is too susceptible to our hot dry spells in early summer and if possible some other crop should be found to serve as a substitute for white clover under unfavorable seasons. Sweet clover or "bee clover" as some call it, has already shown promise under our conditions and it will be investigated thoroughly.

In coöperation with Missouri beekeepers and the recently incorporated Missouri Apicultural Society, the Entomological Department of the University hopes to be able to help develop and direct a more intelligent and a more profitable system of beekeeping in the state. In the future, in this state we must have more intelligent, intensive and less extensive beekeeping.

A NEW METHOD OF SUBTERRANEAN FUMIGATION

By J. S. HOUSER, *Wooster, Ohio*

Some years since while in the employ of the Cuban Agricultural Experiment Station, the writer started an investigation of methods for the control of the fungous-growing ant, *Atta insularis*, known locally as the bibijagua. The studies were interrupted soon after they were commenced, and were never completed, but a start was made in the development of an unused principle for subterranean fumigation which gave evidence of such promise that it has seemed worth while to place it on record.

This ant is to Cuban agriculture and horticulture what the white grub is to the northeastern quarter of the United States, *i. e.*, the most generally destructive single insect pest. In passing, it may be well to note that the nature of the injury consists in the insects stripping the foliage from plants, the mutilated leaves being taken to galleries in the soil where they are used as a media for the growing of the fungous gardens. The various species of Citrus leaves seem the preferred sorts, but, in the absence of these, a large number of other plants are used. Occasionally an entire tree is stripped of its foliage during a single night, it being the habit of this insect to confine its marauding expeditions to the late afternoon and dark hours of the night.

The herbage is piled in culture chambers located beneath the surface of the ground, the average size being that of one's two clenched hands. In newly established colonies these chambers are few in number and are located near the surface of the ground and there is little external evidence of the colonies; but in aged, well-established colonies, the ramifications sometimes extend to a depth of eight feet and a large mound of earth is thrown up above. Such colonies have a number of entrances, some directly above and some a considerable distance away, these being reached through tunnels. The mound itself is a perfect labyrinth of passageways and fungous gardens, the ants being found in all parts of it. Swarming occurs in the spring at which time the new queens in immense numbers emerge from the old colonies and establish new ones.

Three methods of control have been practiced, briefly described as follows:

(1) The digging out method.—With this process, the formicary is excavated and the ants and their fungous gardens are collected and burned. It is expensive, laborious and only moderately successful.

(2) The carbon bisulfide fumigation method.—With this, the liquid bisulfide is poured into the openings to the nest and the fumes allowed

to settle. The weakness of this method lies in the fact that the soil quickly absorbs the liquid and the fumes are liberated so slowly that a small percentage only of the efficiency of the material is realized.

(3) Fumigation with sulfur fumes.—This process involves the use of a special apparatus for generating the sulfur fumes. The fumes, generated by a fan or bellows, are introduced under pressure into the galleries of the nest. The apparatus is cumbersome and slow to operate, much time being lost in building the charcoal fires in the generator. Moreover, the fumes possess only moderate killing power, and, being lighter than air, are with difficulty forced to the utmost parts of the ant-hill. For the same reason, the fumes have a tendency to rise and escape just as soon as the pressure above is released.

The principle of the method of control, used by the writer, consisted in forcing vaporized carbon bisulfide into the ant-hill. Stated briefly, a jet of air was liberated at the bottom of a volume of carbon bisulfide contained in a closed vessel, and the air, bubbling up through the liquid, vaporized the bisulfide. The vapor was then forced through a tube out of the generator and down into the galleries of the ants.

Both laboratory and field tests were conducted, the former to determine the actual killing power of the gas and the latter to determine both the killing power and general practicability of the method under field conditions.

For the laboratory tests, the gas generator consisted of a wide-mouthed bottle with two glass tubes passing through the cork, one of which extended to the bottom of the bottle and the other just through the cork. One hundred cc. of Taylor's Fuma carbon bisulfide was poured into the bottle and air forced through the long tube. The impregnated fumes were conducted through a tube to an open-mouthed bottle into which the ants were placed. A uniform pressure of four pounds to the square inch was maintained and the air-conducting tube was just large enough in diameter to prevent the apparatus from bubbling over. A large series of tests were made, wherein lots of four or five ants were placed in the bottle for receiving the charged air and exact record taken of the time required for each ant to stop movement after the gas was introduced. The average was about thirty-three seconds for workers and a little less time for soldiers. If the ants were left in the bottles they did not revive.

When the generating cells were arranged in series of three, as was anticipated, a little less time was required for killing, since the charged air passing from cell No. 1 carried away a part of the bisulfide of No. 2, and a less amount of No. 3, thus indicating that the air after passing

through the three cells was more heavily charged with the bisulfide than after passing through one cell only.

For the field work, an iron retort was constructed having a quarter-inch gas-pipe passing through the lid to the bottom of the apparatus, and an opening near the top to which was joined a rubber hose. The other end of the hose was connected to the stem of a metal funnel, placed in an inverted position over the entrance of the ant hill and the earth banked up about the funnel's sides. About two litres of bisulfide was poured into the apparatus and air from a blacksmith's bellows forced through it. Working in fields where there were numerous, newly established colonies, thus necessitating considerable moving about, approximately two litres of bisulfide were used per day. As compared with the sulfur fumes method, it is more rapid, convenient, and, so far as the writer was able to judge, during the short time after the work was started that he remained in Cuba, the results seemed more lasting.

The field apparatus was exceedingly crude, and would admit of much improvement. An air pump instead of a bellows and a thin sheet-metal retort instead of an iron one would both lighten and simplify the machine.

Should future studies demonstrate the indicated effectiveness of the method described, its usefulness as a means of destroying the Attiine ants alone would be rather extensive, since according to Wheeler the range of distribution of this tribe is between the 40th parallels, and, should the treatment prove effective and practicable against other earth-inhabiting ants, its range would be considerably increased. Introducing the gas under pressure, the gas being heavier than air, and the cheapness of the process, are all points in its favor.

SOME WORK OF THE EXTENSION ENTOMOLOGIST IN KANSAS AND MISSOURI

By Thos. J. Talbert, *Extension Entomologist, Agricultural Extension Service, University of Missouri, Columbia, Mo.*

The chief object of the extension entomologist is to acquaint the gardener, the orchardist and the farmer with the practical facts about the habits, life-histories, injuries and control of insects. When this has been done the producer is more capable of intelligently shaping his farm practices in a way that will be unfavorable to the development of injurious insects. He is also more interested in his work, and if sprays, poison bait, or mechanical barriers are necessary to control the pests, he knows how to prepare and how to use them most effectively.

Field meetings and demonstrations are of great value to the farmers because they are able to study the insects in their different stages upon their food plants. The farmers learn in the field in a few minutes more than any amount of reading or lecture courses could teach them. They are also freer to talk and to ask questions when in the field. If their interest and attention is aroused in the field, the literature on insects and their control appeals to them and they will make a study of it with the determination of putting into practice the remedies or control measures suggested.

The apparent indifference and lack of knowledge on the part of many farmers concerning insects is due perhaps to a number of causes. Prominent among these is the small size and insignificant appearance of many injurious insects. If the pests were as large as hogs, sheep, colts or calves no doubt their habits, life-histories and control would be well understood by every farmer. The damage and ravages of insects are often attributed to floods, storms, droughts, lack of soil fertility and the like. It is also a fact that the general public knows less about insects than any other branch of agriculture. Many country school teachers are not even on speaking terms with the chinch bug, Hessian fly or army worm. A few farmers will say: "There is no use of trying to control the insects, because we have always had them with us and we always will have them. We will just have to depend upon the weather and the Lord to control them—that's all."

This indifference and lack of interest in insects is not confined entirely to farmers. Many business men, professional men, and college teachers have no notion whatever of the value of a knowledge of insects. It is a sort of a general notion among some that a discussion of insects is going to be dry and uninteresting and it is not worth while anyway. When the subject is handled properly, however, it is equally as interesting as any other phase of the extension work. In many cases farmers have been heard to say: "Well, I am not much interested in bugs, I wish we had a man here to talk live stock." When once the farmers are shown the insects and their work in the fields, they are anxious to know more about their habits, life-histories and control. They see at once that their health, happiness and prosperity may depend in no small way upon a knowledge of insects. Farmers are always immensely interested in a practical discussion on insect control.

Some Practical Demonstrations

About the middle of last June the so-called wheat head army worm (*Meliana albilinea*, Hbn.) appeared in damaging numbers in many

of the wheat fields of central Kansas. Hurry-up telegraph messages and long distance telephone calls concerning the army worms poured into the office of Professor Dean, head of the Department of Entomology, Kansas State Agricultural College.

When the extension entomologist arrived at Nickerson, Kansas, to investigate the trouble, to his surprise about thirty farmers met him at the station in automobiles. Many specimens of the worms and their work upon the wheat were shown. After a brief discussion of the pest and the measures of control at the railroad station, we were taken to a wheat field about seven or eight miles from town. Here we found about one hundred and twenty-five farmers present and after another discussion of the pest we proceeded to the wheat field. After a thorough investigation of several fields it was found that most of the worms were present along the ravines, around straw piles and places where the wheat grew the rankest.

That afternoon a meeting was held in the town hall at which more than two hundred farmers were present. A two-hour discussion of the army worm and the Hessian fly held almost every farmer in the hall during the warm afternoon. A night meeting was held in a neighboring town at which 75 farmers attended. The farmers were interested because their wheat was being completely destroyed by the worms and they could plainly see that unless something was done at once their wheat crop would be ruined.

A formal declaration of war was issued against the worms and the ammunition used consisted of the poison bran mash made according to the Kansas Agricultural College formula, 20 pounds of wheat bran, 1 pound of Paris green, 3½ gallons of water, 3 oranges or 3 lemons and 2 quarts of molasses. The poison bran mash was sown broadcast in the wheat fields during the later afternoon and at night. In most cases it was not necessary to sow the entire fields because the worms were often damaging only the rankest growing wheat. An effort was made, however, to sow the poison bran wherever the worms were numerous enough to cause any noticeable injury.

More than two hundred farmers made use of the poison bran mash on that evening and out of about half that number reporting the following morning every one said that the poison bran mash was almost 100 per cent effective. It was difficult to find a single live worm where the bran was sown. The dead worms were so thick over the surface of the ground that it was difficult to make a shoe track without crushing a half dozen or more worms. One farmer in describing the results said: "I hunted an hour in my wheat field this morning to find a live worm. In all I found one and it died while I was watching

it." The wheat was almost completely destroyed in the badly infested fields where the poison bran mash was not sown.

Hessian Fly Campaign in Missouri

Every section of Missouri was covered in the campaign against the fly during August and September. More than sixty meetings were held and about three thousand farmers studied the fly and learned more about its habits and the methods of controlling it. The insect was studied at first hand in its different stages in the fields and valuable information and data was obtained.

At the beginning the idea was to acquaint the wheat-growers with the habits, adaptations and characteristics of the insect, believing that such a knowledge would help them combat the pest. With this in mind many meetings were held in the old wheat fields where it was usually possible to study the Hessian fly in the egg, maggot, flaxseed and adult stages. Here in a few minutes the farmers were able to learn more about the fly than any amount of reading or lecturing could possibly teach them.

During every field meeting the farmers seemed freer to ask questions and a great deal more interest was manifested than is usually the case in the schoolhouse or lecture room. It was said many times by wheat-growers that they had learned more about insects during the 20 or 30 minutes spent in the wheat field than they ever knew before.

Many meetings were held in the fields where the farmers were threshing wheat, filling the silo or making hay. In some cases the Hessian fly was discussed with individuals or with groups of four or five until all the farmers present had been reached, while at other times all the farmers were addressed at the noon hour. In this way the meetings did not interfere with their work. By means of samples of old wheat stubble and volunteer wheat the discussions were made as practical as possible.

Rural schools and high schools were visited. The pupils were taught by means of charts and field specimens the life history of the Hessian fly, its habits and the best methods of controlling it. After the meetings it was common to hear the farmers say: "Well, if I had known as much about the fly last year as I do now it would have saved me several hundred dollars."

The writer was employed last year by the Kansas State Agricultural College as Extension Entomologist and on the first of August, 1915, he accepted a similar position with the Missouri College of Agriculture.

AN INVESTIGATION OF THE SUPPOSED IMMUNITY OF SOME VARIETIES OF WHEAT TO THE ATTACK OF HESSIAN FLY

By L. HASEMAN, *Columbia, Mo.*

It is a well-known fact that some varieties of trees and other plants possess a greater or less degree of immunity to certain diseases and insect pests, while other similar varieties or strains are very susceptible to them. This is true not only of the plants themselves but also of some fruits and seeds. Among practical farmers and grain breeders there is a general impression that some strains of wheat are less affected by smut, rust and Hessian fly. If this is the case, other things being equal, that strain which has tendencies toward immunity would seem to be the one to grow. However, there are many other factors which must be considered.

The variety of wheat which is most susceptible to fly attack may possibly be more hardy, and more given to stooling and in this way it may perhaps yield more grain than other varieties less severely attacked by the fly. In other words one variety may be able to furnish food for a large crop of flies and yet yield more grain than a second less susceptible variety. Since the farmer is after yields, he wants to grow that variety which for his locality, gives the greatest yield. The Hessian fly, while a most destructive pest of wheat, can, with proper farm practices, be kept entirely under control. Under such conditions the use of resistant strains proves of but little value. However, where less careful systems of farming are in force, great good would come from the development and use of a heavy yielding, resistant strain of wheat.

For the past few years the Hessian fly has been unusually abundant in the Mississippi Valley and in spite of all that we have been able to do in this state the annual loss from the fly has been severe. This inability to secure the needed coöperation of all farmers in some sections for controlling the fly through practical farm practices has led us to undertake this investigation. If we can find among our standard or new varieties of wheat one or more which will stand up better under fly attack, and give even only a small percentage more yield the work will not have been in vain.

The investigation has been under way for only one season and comparatively little real valuable data has been gotten. Our plan first of all is to determine whether or not the fly really breeds more abundantly in some varieties than in others. If it does we have at

least something definite to work on. On the other hand, if the fly is found to breed in equal numbers in the different varieties there is still the possibility that some of the varieties will be able to resist the effects of the fly better than others.

Studies are being made to determine whether or not physiological differences in plants of the different varieties, chemical composition of the sap, ash content and other factors associated with the plant itself, tend to make plants of one variety more attractive to the fly. Such factors as stooling, hardiness of plants and strength of stalk, which may tend to help the plant resist the work of the pest, are also being investigated. In the end the subject of yield must be considered. Much valuable data on comparative yields of the standard varieties, in different sections of the state both for fly-years and fly-free years are available from the records of the Department of Farm Crops, but additional records will be secured from carefully laid out plots where the factor of fly injury alone will be considered.

RESULT OF FIRST YEAR'S WORK.—In the first year's work only three varieties of wheat were used: Fultz, Fulcaster and a supposed fly-immune variety developed by a farmer. The plots were sown side by side the 24th of October, 1914. The soil was rich and had stood idle the previous summer. The plot was a quarter of a mile from the nearest wheat and a mile from badly infested wheat. The late date of sowing, together with the distance from infested wheat, prevented the fly from appearing in it in the fall. In order to make sure that some fly would be present in it in the spring, infested volunteer wheat was collected and evenly distributed in small piles about the plots on April 10, 1915. Two days later flies were found on the wheat and the plots became severely infested.

On May 1, maggots were found to be abundant in all three of the plots and on May 3 the first flax-seed stages were found. On May 10, samples of wheat were collected at random from the three plots and counts made to determine the number of larvæ and "flaxseeds" present. From these counts the following data was secured:

Variety	Per Cent of Stools Infested	Greatest Number in a Single Stool	Average Number per Stool
Fultz	58	18	2.72
Fulcaster	66	8	1.46
Check	54	12	1.7

In Fulcaster the infestation was more general, though decidedly lighter than in the other two varieties. Fultz was decidedly the most heavily infested which agrees with the observations of practical farmers. The check or supposed immune variety was slightly more heavily infested than Fulcaster.

A second set of samples were collected on June 18, which gave the following data:

Variety	No. of Stools	Maggots	Flax-seeds	Parasit-ized	Emerged
Fultz	100	92	69	12	3
Fulcaster	100	11	23	4	6
Check	100	0	21	0	3

Here again Fultz showed a decidedly heavier yield of maggots and "flaxseeds" while the check variety showed fewer than Fulcaster. In all three of the varieties there was a smaller total number of maggots and "flaxseeds" than on May 10. Some had emerged to form a partial second spring brood and the wheat was all badly lodged which with the excessive rainfall made it difficult to collect all the "flaxseeds" when the samples were gathered.

From this data it seems unquestionable that some varieties become more severely attacked by the fly than do other varieties. Fulcaster shows decided tendencies toward immunity as compared with Fultz in this test at least. This data also show that a supposed highly immune variety may in reality be as badly attacked as some of our standard varieties.

In connection with the studies on the stooling properties of the three varieties under consideration, counts were made on June 26. From these counts the following data were secured:

Variety	Average Number of Stools per Plant
Fultz	4.39
Fulcaster	3.71
Check	3.67

In this particular experiment Fultz which was the most severely infested showed a slight increase of stools, though not enough to counter-balance the greater supply of flies which it was called on to feed.

Lodging.—Observations on the tendencies of the three varieties to lodge showed that there was little difference between Fultz and Fulcaster but the check variety practically all lodged. In all of the varieties lodging was very severe as would naturally be expected from the extent of infestations.

Ash Content of Plants and Straw.—Determinations of the ash content of the different varieties have been made to see if it varies materially in the three varieties and also if it perhaps may be a factor in attracting or repelling the fly. Analyses have been made of young wheat plants taken when the fall brood of maggots were at work; also of the mature straw. These analyses do not show any very material

difference but may prove to be of interest. Further studies are to be made along this line. The analyses gave the following data:

Variety	Per cent Ash in Young Plants	Per cent Ash in Straw
Fultz	15.146	5.147
Fulcaster	15.379	4.598
Check	14.796	4.751

The extent of infestation in the three varieties seems to vary directly with the ash content.

YIELD.—Our records on yield for the first year's work are unsatisfactory though they give some light on the comparative yields of the three varieties under investigation. A plague of English sparrows interfered with the data on total yields. Representative heads were collected on June 26 and weighed.

Variety	No. of Heads	Weight	Weight per 100 Heads
Fulcaster	371	334 grams	90.03 grams
Fultz	439	324 grams	73.80 grams
Check	367	273 grams	74.38 grams

Fulcaster far outweighed both the other varieties. It is a bearded variety, however, which perhaps accounts for part of the extra weight. These heads were not threshed since the main crop was lost.

PHYSIOLOGICAL STUDIES OF PLANTS.—In connection with investigations by the Department of Botany on the smuts and rusts of wheat, observations are being made with a view of detecting any structural difference in the plant of the standard varieties of wheat. These data will also be of value in connection with this work and will be available later.

PLANS FOR SECOND YEAR'S WORK.—This work is being continued and this year the following varieties are being used on a larger scale: Harvest King, Beechwood Hybrid, Check mixed, Mediterranean, Deitz, Turkey, Check pure, Fulcaster, Fultz, Michigan Amber and Pool. Sowings have been made early and late to determine what effect it has on the fly and on the wheat itself as regards winter injury. The investigation this year will also include data on these varieties in the experimental fields of the Department of Farm Crops both here at Columbia and at the substations over the state. This it is hoped will enable us to present more really valuable data on this subject another year.

CONCLUSION.—From the first year the only important conclusion that has been reached, is that some varieties of wheat are more severely attacked by the fly than others. The data at hand is insufficient for definite conclusions regarding the other subjects under investigation.

THE SMALL PINK CORN WORM (BATRACHEDRA RILEYI WALS.) IN MISSISSIPPI

By R. W. HARNED, *Agricultural College, Mississippi*

During the past fourteen months the small pink corn worm, *Batrachedra rileyi* Wals., has attracted more attention than any other insect pest occurring in Mississippi. During the nine years that the writer has been in the state, he has observed these small pink larvæ on several occasions feeding in injured cotton bolls, in old corn cobs, and in corn that had previously been damaged by other insects. During November and December 1914 the writer received hundreds of complaints in regard to the work of this insect in stored corn. Letters came every day, telephone calls for help were many, and the extension workers of the college stated that at many farmers' meetings the principal topic of discussion among the farmers was the so-called "new pink worm" or "pink weevil" of corn. It may be of interest to note that most of the correspondents who sent these insects to us were from the central part of the state. Attala county contains the geographical center of the state. Over 75 per cent of the complaints in 1914 came from Attala and four counties adjoining it. Although these insects occurred in all parts of the state it was only in these central counties that they were numerous enough to do very serious damage. However, a year later or during the past three months (October to December 1915), dozens of complaints have been received in regard to these insects damaging corn from over forty different counties. The accompanying maps show the localities from which the worms were received with records of their damage to corn in 1914 and in 1915. Briefly the situation is this: In the fall of 1914 the worms caused very serious loss to corn over a limited area in central Mississippi but were to be found in corn in all parts of the state; in the fall of 1915 their damage was greatly reduced in central Mississippi but increased considerably in other sections of the state although in no section did they cause as much loss as in the central counties in 1914.

There is no doubt in the writer's mind but that the damage caused by the pink worms has often been greatly exaggerated but his own observations have convinced him that this species has done more damage to corn during October, November, and December of both 1914 and 1915 than all other insects combined. A few quotations from correspondents' letters will show how some of the farmers have regarded this insect:

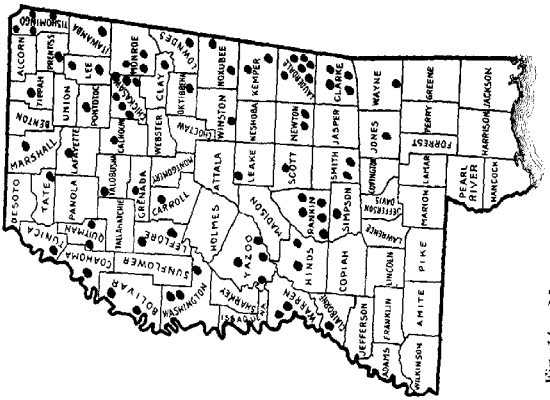


Fig. 14.—Map of Mississippi showing localities from which *Intaraclavia virgi* was received in 1915.

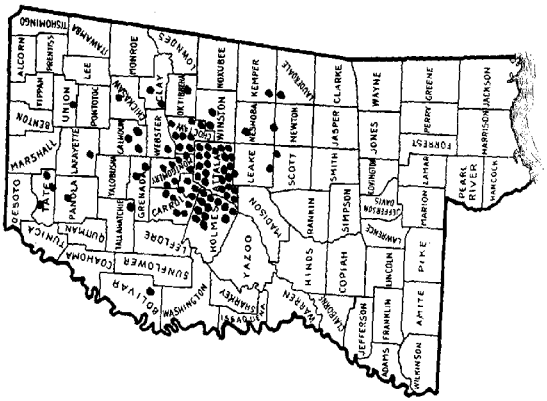


Fig. 13.—Map of Mississippi localities from which *Intaraclavia virgi* was received in 1914.

"We are in the midst of a bad fix in our neighborhood. There is a small pink worm eating the corn. It appears in the end of the ear and eats back as it goes. It does not take long to ruin the ear."

"We have discovered a small red worm that is destroying the corn. They begin in the grain next to the cob and eat the kernel up."

"They enter the grain at the little end next to the cob and eat the grain up. Some farmers report that cribs of corn have been destroyed. Investigations show that they are in all cribs of corn. . . ."

"They appear to be worse in damaged corn but are found in sound corn."

"I find a small pink worm in nearly every grain. They seem to work from tip to butt."

". . . is eating up the corn in this section after it has been harvested and put into the crib."

"Practically all the corn in this section is infested more or less."

"They have eaten some of the corn entirely up. They are very common throughout this county."

". . . is eating everybodies' corn in this country."

"Every crib in this community is infested."

". . . is eating up the corn here after it is cribbed. They are in all the cribs here. One man told me he had 500 bushels and would take $5.00 for it."

"In the fifty years I have been farming I have never (before) found these worms in corn. They are general throughout this section."

Although the small pink corn worm has apparently never before attracted as much attention as it has recently in Mississippi it has probably long been a pest of minor importance but usually mistaken for some other insect. Walsingham [1] described this species in 1882 from specimens "bred from rotten cotton-bolls." Chittenden [2] gives us the first record of it as a corn insect. In 1897 he reared moths from larvæ both in cotton-bolls and in corn from the field sent from Texas by Mr. E. A. Schwarz. Chittenden also brings out the fact that this is the insect mentioned by Townend Glover in 1855, 1856, and 1877 as occurring in the corn fields of the South and as attacking corn in the husk. He gives it the name of "Glover's grain moth" and quotes Glover as stating "that the larvæ 'appear to attack corn out of the field as well as in,' and that the insect lives in injured cotton bolls." In 1909 Swezey [3] shows that in Hawaii they have quite general feeding habits. Among other things he says: "Once I found them very numerous in sweet corn ears, feeding on the silks, inner husks, pith, and other parts of the cob. I have also seen them in ears of field corn, eating into the kernels of corn and into the cob." In 1911 Tucker [4] records these larvæ as feeding in old corn stalks in Louisiana, especially rotting, rain-soaked stalks. He also frequently found this

[1] Trans. Am. Ent. Soc., X, p. 198.
[2] Bul. 8 n. s., Div. of Ent., U. S. D. A., p. 33.
[3] Hawaiian Sugar Planters Sta., Div. Ent. Bul. 6.
[4] Canadian Entomologist, XLIII, p. 28.

species in green corn stalks and in ear tips where they were associated with or followed other insects.

Only a brief summary of some of our observations can be given at this time: 1. The worms were found in every corn field observed during the autumn months of 1914 and 1915. 2. The number of ears infested with this species in the different fields examined varied from 10 per cent to 99 per cent. 3. The worms appeared to be more numerous in corn grown on hill lands than on bottom lands. Even in fields containing both hill and bottom land, the worms were more numerous in the corn growing on the high land. (This is probably due to the better condition of the corn from the bottom lands.) 4. In general early maturing corn contained fewer worms than late corn. 5. Although the worms appeared most numerous in the stored corn during November and December, a few were present as late as April 1. 6. These worms are most numerous in ears of corn that have been damaged by the corn-ear worm, or by other insects, and in imperfect ears; but many perfect ears that showed no sign of other injury were found to contain a few of these worms. 7. The tips of the ears are most likely to be infested but the worms may be found at any part of the ears or in the cobs. 8. The number of worms was apparently greatly reduced by the cold weather of January 1915 when the temperature dropped below 10 degrees F. on several nights. 9. During the fall of 1915 large numbers of dead larvæ have been found. The cause of their dying has not been determined definitely. 10. The worms eat the corn grains by finishing grains that have been partially devoured by other insects, especially near the tips of the ears; by entering them from the cob and leaving only an outer shell; by tunnelling through several grains in a row; by eating the tips next to the cob of several grains in a row; by eating the outer parts of several grains in a row just beneath the husks; by feeding between the rows and eating parts of the grains of two rows. 11. Sorghum and Kafir corn heads on the college farm were badly infested with the worms in July and August 1915. Specimens in Kafir corn heads from Quitman, Mississippi, sent to Washington were determined as this species by Dr. F. H. Chittenden. 12. The worms have been counted from several hundred ears. In December 1915, Mr. G. F. Arnold carefully counted the worms in 74 ears taken at random. He found an average of $4\ ^{8}/_{37}$ worms to the ear. Twenty-four of these ears contained no worms. The worst infestation was in a small ear of poor corn that contained 50 pink worms, 2 in grains of corn, 27 between grains, and 21 in the cob. The next worst ear contained 41 worms, 13 in as many grains, 20 between grains, and 8 in the cob.

COÖPERATION IN THE ESTABLISHMENT OF STATE QUARANTINES

By J. EDWARD TAYLOR, *State Horticultural Inspector, Salt Lake City, Utah*

As the establishment and enforcement of quarantines is included in most crop pest laws, some observations in connection with their operation should be of interest to the members of this association although the necessity for state quarantines was very much lessened by the creation of the Federal Horticultural Board and it is to this source that we must look for maximum protection from introduced crop pests. From personal experience it would seem that our first duty is to get the Federal Board to take action. If this fails, state quarantines should be established under the most urgent conditions and should include such commodities as a reasonable effort will allow us to effectively control.

In our ever expanding and complicated commercial system, state lines are being rapidly erased. A single state is too small a unit to prevent traffic in staple commodities. The facilities at the disposal of most state quarantine officers are entirely inadequate when matched against commercial interests affected by quarantine measures. It is, therefore, important that the various states which are threatened by invasion of insect pests or plant diseases get together and close up the avenues of invasion as tightly as possible—a task which one state can hardly accomplish. Too many of our state quarantines are a delusion and a serious reflection on the general principle of pest dispersion.

The quarantines established against the state of Utah by the states of Arizona, California, Idaho,[1] Montana and Oregon on account of the alfalfa weevil which infests this state have given the writer an opportunity of observing the practical operation and effectiveness of state quarantines. In the light of scientific investigations which have been made, relative to the spread of the alfalfa weevil, not one of these quarantines, as a whole, is justified, and no state is getting protection from the alfalfa weevil by their establishment. We have had the weevil in Utah for approximately twelve years and although the infested area is being extended gradually by the insects flying and crawling, there is not a single instance where a colony of weevils has become established at any distance from the previously infested points. If ordinary commercial traffic had been a factor in extending infesta-

[1] In fairness to the state of Idaho it should be said that their quarantine was forced upon them by the authorities of California who made this one of the conditions upon which part of Idaho was released from the general quarantine which originally included both Idaho and Utah.

tion there would have been out-breaks at points considerably beyond the infested area. The introduction in Utah, presumably from Europe, is the only known case where such transportation occurred, and we do not know how this happened.

A careful investigation made by the U. S. Bureau of Entomology, in coöperation with the authorities of Utah, of the possibilities of alfalfa weevil being carried in commercial shipments, especially of alfalfa seed, nursery stock, fruits and vegetables, has been made, covering a period of three years. These investigations show that the only danger of spreading alfalfa weevil is by shipping alfalfa hay or any produce which has been handled in contact with it between the 15th of July and the beginning of winter and there is no case on record where such transportation of the weevil has occurred. Early potatoes are practically the only crop that presents any danger from this source, and it is an easy matter to handle this crop in such a way as to eliminate all risk.

The alfalfa weevil being a comparatively new pest as far as America is concerned, it is not surprising that states, establishing embargoes in the beginning, acted largely on fear and supposition and consequently established quarantines which are irrational and more or less arbitrary. Such quarantines as have already been established show a lack of coöperation between states as is indicated by the following digest of existing embargoes:

NURSERY STOCK:

Arizona—Entrance prohibited.

California—Nursery stock must be packed in fresh shavings, excelsior or other suitable packing (except tule, hay, and straw), and containers and cars must be fumigated with potassium cyanide, both at point of origin and delivery. Must be consigned to a quarantine officer designated by State Commissioner of Horticulture, who will fumigate as for alfalfa seed.

Idaho—Same instructions in packing as California, except tule hay can be used if fumigated and accompanied by an official certificate of fumigation.

Montana—Prohibited unless accompanied by an official certificate of fumigation.

Oregon—Hay, straw, tule, grass and forage plants must not be used in packing any nursery stock shipped into Oregon.

FRUITS AND VEGETABLES:

Arizona—Entrance of fruit prohibited. No restriction on vegetables.

Montana—Entrance prohibited from April to October inclusive (excepting that after August 1, fruits and vegetables may be shipped from points where inspection service is maintained by State Horticultural Inspector of Utah, all shipments to be handled under special arrangement and to bear an official certificate of inspection).

(No restriction in other states.)

ALFALFA SEED:

Arizona—Entrance prohibited.

California—Seed must be enclosed in weevil tight containers seamless (sacks) consigned to a quarantine officer, at a place designated by the State Commissioner of Horticulture of California, for disinfection at cost of consignee or owner. After disinfection seed will be released upon payment of charges.
Idaho—Same as California.
Montana—Must be fumigated at point of shipment and be accompanied by an official certificate.
Oregon—Entrance prohibited.

HAY, ALL KINDS:

Entrance prohibited (all states).

STRAW:

Arizona—Entrance prohibited.
California—Entrance prohibited.
Idaho—Entrance prohibited.
Montana—(Excludes only forage crops).
Oregon—Entrance prohibited.

BEES IN HIVE:

Arizona—No restrictions.
California—Entrance prohibited.
Idaho—Entrance prohibited.
Montana—No restriction.
Oregon—Must not be packed in hay, straw, tule, weeds or forage crops.

HOUSEHOLD GOODS:

Arizona—Must be inspected and accompanied by an official certificate of inspection made under oath.
(No restrictions in other states.)

LIVESTOCK:

Arizona—Special arrangements must be made with the Arizona State Entomologist before shipments are made, and in any case must be transferred to clean cars before crossing the state line.
California—Hay and straw must not be used in cattle cars.
Idaho—Same as California.
Montana—No restrictions.
Oregon—Hay, straw, grass and forage crops of all kinds must not be used in cattle cars.

GRAIN:

Arizona—Entrance prohibited.
(No restrictions in other states.)

It will be noted that some serious items of commerce are included in the embargoes. Utah produces a surplus of nursery stock, fruits, vegetables, alfalfa seed and live stock which is marketed in surrounding states and well established lines of commercial traffic in some of the commodities were suddenly stopped with consequent serious financial loss and disturbance to the business interests of both states.

The quarantine on fruits and vegetables going into the state of Montana furnishes the best illustration of some of the evil effects of

the quarantine system. The points principally affected are from Ogden north to the Utah state line where much of the planting for the last twenty-five years has been made with the idea of supplying the Montana market. The production of berries and bush fruits, which of necessity must go into nearby markets, is large throughout this section. The matter of readjusting the market for the fruit, etc., which had otherwise gone into Montana has caused a demoralization in the remaining local markets and a consequent serious financial loss. The competition of the Utah fruit in the Montana markets was from Oregon and Washington, but with the establishment of the quarantine, fruits and vegetables from Utah were shut out, and although the quarantine has since been modified, the Montana market has been lost to the growers of this state with no gain to Montana in the way of protection from the alfalfa weevil.

Another very serious injustice has been done to the state of Utah by including alfalfa seed in quarantine measures. When we refer to alfalfa weevil, the average layman and seedsman immediately associate it with a large group of weevils which infest seed of all kinds and figure naturally that it is a seed weevil. As a matter of fact it has nothing whatever to do with alfalfa seed and is never in any way associated with it and yet it has been the cause of a very vital prejudice against Utah seed in certain markets.

Under-ground routes have been established to a limited extent so that the object of the quarantine was defeated. The quarantine of Utah alfalfa seed had the effect of cutting the price of Utah seed in one of the states from thirteen cents to eight cents per pound, while the price of seed from the surrounding states, of course, was not affected. The result was that Utah seed immediately lost its identity as a Utah product and was shipped by way of other states into states having quarantines at the full market price. If the transportation of quarantined articles had presented any danger, the evil was far greater by the under-ground route than if the goods had gone through the usual lines of traffic where they could be protected by an inspection system. Experience with these quarantines shows above all things that where there is no coöperation between states none of them gets the protection which the quarantine anticipates.

The establishment of irrational and arbitrary quarantines, especially where they affect important items of commerce, is apt to lead to retaliatory measures being adopted by commercial interests which are affected and increases the danger of spreading the pest by incendiary measures through districts which seek by means of their quarantines to keep it out. There are some cases on record where incendiary methods have been adopted by commercial interests for their own

gain and this should be seriously considered where quarantine measures are framed. From a practical standpoint the writer does not hesitate to say that if state quarantines are to be effective, the closest coöperation between affected states must be established, and their effect on well established lines of commerce be seriously considered before they are promulgated.

CONTROL OF THE VARIEGATED CUTWORM IN VENTURA COUNTY, CALIFORNIA[1]

By G. E. BENSEL, *Collaborator, Truck Crop and Stored Product Insect Investigations, U. S. Dept. of Agriculture*

RECENT INJURY

The variegated cutworm (*Peridroma margaritosa (saucia)* Hübn.) is widely distributed in Ventura County, California, and has done considerable damage in the last year (1914) to the sugar beet crop. The first serious outbreak occurred in April, 1913, when about three hundred acres of young beets were cut off just beneath the surface of the ground. These dark brown "worms" were observed concealing themselves an inch or two underground during the day time, where in a dormant stage near the attacked plants they were ready to emerge on the return of night. It was also noticed that they generally followed the rows of beets, that very few fed during the day and that most of the damage was done during the night and early morning. The depredation is completed in so short a time that only preventive remedies could be recommended. The entire field was destroyed in less than four days. This field was summer-fallowed the previous year and the last generation evidently had deposited their eggs on the volunteer vegetation and this outbreak was the result of overwintering larvæ. This field was replanted but the cutworms destroyed the stand. It was then decided to postpone the second replanting with the object in mind that possibly the cutworms would, in the meantime, mature, enter the earth, and pupate. This supposition proved true and the third stand was unmolested. Unfortunately a second serious outbreak occurred in the same field about six weeks later. This time large beets were attacked and completely stripped. Only the stems were left untouched; even the roots were considerably damaged. The cutworms eat more ravenously during cool and foggy weather; hot sunshine checks to a large extent their ravages. The yield of the affected field was considerably reduced and very likely the sugar content of the beet was also materially reduced, as the elaboration of the sugar occurs in the leaves, which were largely damaged.

[1] Published by permission of the Secretary, U. S. Dept. of Agriculture.

Natural Enemies

Among natural enemies observed were two species of *Calosoma*, *semilaeve* Lec. and *cancellatum* Esch. which contributed to the destruction of this cutworm. Although predaceous insects and parasites—among which the Ichneumonidæ must be mentioned[1]—destroy annually a great number of cutworms, practical remedies must be found to help these natural enemies in the control of this pest.

Methods of Control

In some cases rolling a young stand of beets has been very successful, in other cases no benefit was derived from this operation. If the stand of beets is completely destroyed or not worth saving, the cheapest and best way is to replant the crop, but at least three to four weeks must elapse between the two plantings. Local conditions must, naturally, be taken into consideration. In the season of 1914 no damage by cutworms to young beets was reported. April 20 was the date of the first outbreak on beets. These already had large foliage upon which spraying with arsenicals was tested.

Control by Gasoline Power-Sprayer

A gasoline power sprayer provided with a fifty-gallon barrel and one horsepower gasoline engine capable of maintaining while spraying a pressure of about one hundred and twenty pounds was used. This outfit was mounted on a light wagon with adjustable axles in order to circulate between sixteen and eighteen-inch rows of beets. Two men were required to handle the spraying outfit; one to drive and the other to attend the pump, watch the nozzles and prepare the mixture. The poison was applied at the rate of two pounds of Paris green to fifty gallons of water with the addition of one pound of molasses in order to render the solution more adhesive. Two or even three applications were required to check the work of the cutworms and these applications were made at an interval of four days. After the second application, the voracity of the cutworms decreased considerably. This device covered four rows of beets and sprayed about ten acres of beets in a day at the following cost:

Depreciation of apparatus	$0.35
Gasoline	0.25
Ten lbs. Paris green	2.00
Two horses and two men	6.50
	$9.10

This is approximately $0.90 per acre for each application.

[1] One of the species reared is *Enicospilus purgatus* Say.

Control by Dry Paris Green

The dry application of Paris green by means of a special arrangement on the ordinary horse cultivator was also tested. This method apparently gives a more uneven distribution of the Paris green but has the advantage of giving an extra cultivation to the suffering beets which undoubtedly stimulates their growth and thus increases the resistance of the weakened plants. The dry application was made early in the morning while the leaves were still damp in order to cause the poison to adhere better to the foliage. The tops of the sprayed beets were fed to cattle during the summer and no bad effects were reported.

Ditching

The writer also recommends that around the adjoining fields a ditch about one and one-half feet deep should be plowed as the cutworms are known, under certain conditions, to acquire the marching habit although this has never occurred so far in this locality. The ditch should be constructed with steep sides so that the cutworms cannot climb out and are obliged to travel along the bottom of the ditch and gather in holes placed along the bottom about forty feet apart.

Trapping Moths by Lights

Besides the above-mentioned remedies another preventive remedy was tried which has been used on a large scale in Germany and Russia—the trapping of the adults or moths by means of light traps. In the various infested districts eight large electric arc lamps of 3,000 candle power each were installed, burning four kilowatt-hours a night of nine hours at a cost of approximately thirty cents a night. In the districts where no electric current was available a Milburn portable 500 C. P. acetylene gas light consuming about ten pounds calcium carbide at five cents a pound, or fifty cents a night, was used. Underneath these lights and at a distance of about ten inches a shallow galvanized iron pan four feet in diameter is set on a wood platform six feet above the ground. This pan contains water covered with a light coat of oil. The moths captured were counted every morning and a total of 96,046 moths were captured by the Arnold Dump trap light. All the electric light traps were placed upon the platforms of the sugar-beet unloading dumps which are about twelve feet above the ground. The 96,046 moths were caught during thirty-six nights at a cost of $17.28 (144 kilowatt hours at twelve cents) or approximately at a cost of twenty cents a thousand. The number of moths captured varies greatly with the weather conditions at night. An essential condition for success is that the night should be warm, quiet and dark. During

periods of drought or fogs the moths are difficult to capture. Besides the eight large lights, twenty-four small light traps were installed by individual farmers. These small lights captured about one thousand moths during a favorable night. The total number of moths captured reached the phenomenal figure of 1,000,000 during the season of 1914 at a cost not exceeding twenty-five cents a thousand.

Many entomologists consider this method impractical, claiming that the females are captured after having deposited their eggs and that oviposition occurs immediately after the issuance of the moth. There is no doubt that the traps yield more males than females and that a large portion of females have already oviposited but the writer does not believe that the eggs are deposited immediately after the emergence. Copulation usually takes place very shortly after the appearance of the moths and the writer believes that several days may elapse after the moths appear before all of the eggs are laid. Mr. J. E. Graf, of the Bureau of Entomology, examined last year many captured moths and found that about 22 per cent were gravid females.

To sum up, the writer's experience shows that the treatment herein mentioned is worth the slight expense and although it cannot entirely control the cutworm plague it has extensively contributed to that end.

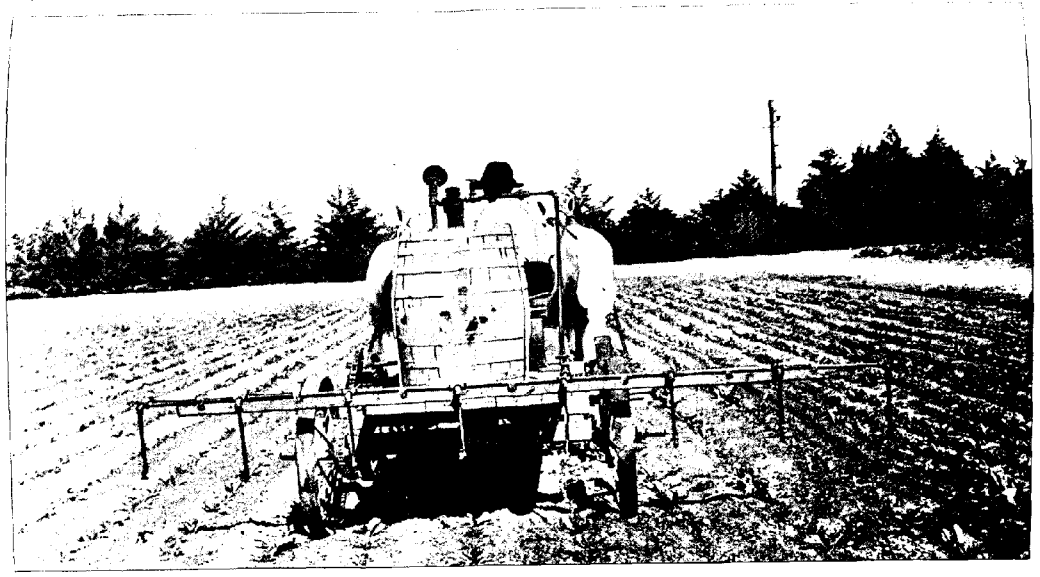
PARASITISM AMONG THE LARVÆ OF THE MEDITERRANEAN FRUIT-FLY (C. CAPITATA) IN HAWAII DURING 1915

By E. A. Back and C. E. Pemberton, *Bureau of Entomology*

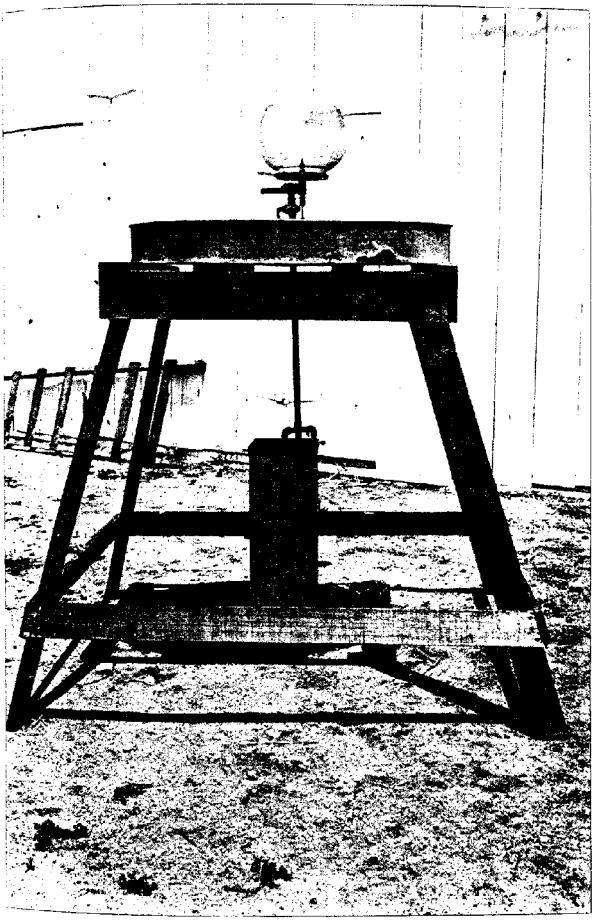
Entomologists interested in the control of insect pests by natural agencies are already aware of the most excellent results obtained in the Hawaiian Islands from the introduction of parasites of the sugar cane leaf hopper (*Perkinsiella saccharicida*) and of the sugar cane borer (*Rhabdocnemis obscurus*). They will therefore follow with unusual interest the progress made by the parasites of the Mediterranean fruit-fly (*Ceratitis capitata*) introduced by Messrs. F. Silvestri, D. T. Fullaway and J. C. Bridwell from Africa and Australia under the auspices of the Hawaiian Board of Agriculture and Forestry.

The Mediterranean fruit-fly, since its introduction at Honolulu from Australia about 1910, has spread to all the important islands of the Hawaiian group, and, because of the great variety of its host fruits, an equitable climate, and peculiar physical conditions of the country, has not only seriously checked the horticultural development of the Islands, but has succeeded in withstanding all attempts directed at its control by artificial measures.

Sprayer used in sugar beet fields for variegated cutworm at Oxnard, Calif. (Original)



Sprayer used in sugar beet fields for variegated cutworm at Oxnard, Calif. (Original)



Acetylene gas globe and trough for capturing cutworm moths at Oxnard, Calif. (Original)

While the export trade of the Islands in fruits except the banana and pineapple has been destroyed by the horticultural quarantines following the advent of this pest, it is hoped that the introduced parasites may be sufficiently effective to make possible the growing for home consumption of certain fruits now always badly infested.

Having undertaken an investigation of the Mediterranean fruit-fly in Hawaii for the Bureau of Entomology in 1912, the writers have had an excellent opportunity to follow the progress of parasitism of this pest. Their work during 1912 and 1913 makes it absolutely certain that no parasitism existed among the eggs, larvæ or pupæ up to the time when Dr. Silvestri arrived with his parasites. In their paper entitled "Parasitism among the Larvæ of the Mediterranean Fruit-fly (*C. capitata*) in Hawaii during 1914," published in the Report of the Hawaiian Board of Agriculture and Forestry for the biennial period ending December 31, 1914, the writers gave a large number of percentages of parasitism obtained during their biological work. The present paper records similar data obtained during the year 1915.

As shown by the reports of the Hawaiian Board of Agriculture and Forestry, the South African *Opius humilis* and the Australian *Diachasma tryoni* were introduced by Dr. Silvestri as a result of the first parasite expedition to West Africa, while *Tetrastichus giffardi* and *Diachasma fullawayi* are the results of the Fullaway-Bridwell Expedition to West Africa. For a full account of these expeditions see the Report for the year 1913–1914, and Bulletin No. 3 of the Hawaiian Board of Agriculture and Forestry.

For the information of the reader it should be stated that a few specimens of *O. humilis* and *D. tryoni* were liberated in the Kona coffee district on June 13, 1913, but in Honolulu neither parasite was liberated until December 1913, when colonies of *O. humilis* were liberated. No *D. tryoni* were liberated in Honolulu until early in 1915. Between October 27 and December 31, 1914, Mr. D. T. Fullaway reports having liberated 14,450 specimens of *T. giffardi* on the Island of Oahu and 2,800 in the Kona and Hilo districts of the Island of Hawaii. Of *D. fullawayi* during the same period but thirty-five specimens were liberated on the windward side of the Island of Oahu, and 195 specimens in the Kona district, Island of Hawaii. Although many more liberations were made during 1915, it is evident that the percentages of parasitism of *D. fullawayi* and *T. giffardi* recorded in Tables I, II and III represent the establishment and control exerted by these parasites during the first year after their liberation, both in Honolulu, and in the Kona district of the Island of Hawaii; while those of *O. humilis* and *D. tryoni* represent the control exerted by these two parasites during their second year after establishment in the

Kona district of Hawaii, but in Honolulu during the second year of *O. humilis* and the first year of *D. tryoni*.

The data in Table I are interesting for several reasons. Although large numbers of *T. giffardi* have been liberated in the Kona district, no specimens of this parasite were bred from larvæ developing in the coffee cherries. All infested coffee cherries were picked from the tree

TABLE I. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN COFFEE CHERRIES (*Coffea arabica*). GROWING IN KONA DISTRICT, HAWAII

Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism				
			Opius humilis	Diachasma		Tetrastichus giffardi	Total
				tryoni	full-awayi		
Kainaliu[1]	1/15-16	126	97.6	0.8	0.8	—	99.2
"	1/16-18	123	92.7	0.8	—	—	93.5
Kainaliu	2/2 - 3	29	65.5	3.4	—	—	68.9
"	2/3 - 8	147	59.1	1.3	—	—	60.4
Kainalui	2/6 - 8	54	85.3	9.3	—	—	94.6
"	2/8 -10	86	86.0	1.2	—	—	87.2
Kainaliu	3/15-18	60	92.0	—	—	—	92.0
"	3/18-19	81	85.1	—	—	—	85.1
Kainaliu	6/18-19	46	63.0	30.4	—	—	93.4
"	6/19-20	65	50.7	41.5	—	—	92.2
"	6/20-21	107	56.0	32.7	—	—	88.7
Honaunau	1/16-18	223	64.1	1.8	—	—	65.9
"	1/18-20	193	56.5	4.7	—	—	61.2
Honaunau	1/19-20	29	82.8	3.4	—	—	86.2
"	1/20-25	127	44.1	0.8	—	—	44.9
Honaunau	2/2 - 3	237	49.3	4.6	—	—	53.9
"	2/3 - 8	514	28.9	7.5	—	—	36.4
Honaunau	2/9 -10	210	64.2	4.7	—	—	68.9
Honaunau	3/19-24	130	73.9	0.6	—	—	74.5
Honaunau	3/24-26	128	81.2	—	—	—	81.2
"	3/26-27	105	76.1	0.9	—	—	77.0
Honaunau	6/17-18	109	46.7	40.3	—	—	87.0
"	6/18-19	222	38.2	47.2	—	—	85.4
"	6/19-20	282	40.0	49.6	—	—	89.6
"	6/20-21	529	33.6	44.6	—	—	78.2
Honaunau	9/19-20	43	13.9	65.1	—	—	79.0
"	9/20-21	122	10.6	69.6	—	—	80.2
"	9/21-22	96	7.2	56.2	—	—	63.4
Kealakekua	2/6 - 8	82	79.0	—	—	—	79.0
Kealakekua	6/16-18	305	31.4	23.9	—	—	55.3
"	6/18-19	285	18.9	29.1	—	—	48.0
"	6/19-20	465	19.7	36.5	—	—	56.2
"	6/20-21	605	7.4	22.7	—	—	30.1
Kealakekua	9/18-19	34	17.6	67.6	—	—	85.2
"	9/19-20	39	23.0	56.4	—	—	79.4
"	9/20-21	91	37.3	48.3	—	—	85.6
"	9/21-22	173	24.8	42.7	—	—	67.5

[1] Each locality recorded in Tables I, II and III represents a separate lot of fruit from which larvæ were secured, and the first percentage under each lot is the percentage of parasitism of the first larvæ emerging. Each ditto mark represents the second, third or fourth lots of larvæ emerging from the same sample of fruit between the dates indicated.

and not from the ground. One specimen of *D. fullawayi* was reared from larvæ collected in coffee during January, or about one month after the first liberation of this parasite in Kona. The most interesting development, however, in the coffee section seems to be the gradual change taking place in the ratio of control exerted by the *O. humilis* and *D. tryoni* shown by the March, June and September data. This increase in effectiveness of *tryoni* seems to be taking place without producing an increase in the total parasitism, but at the expense of *O. humilis*. The percentages of parasitism among larvæ developing in kamani nuts (Table II) and other host fruits (Table III) show fewer negative results than those recorded for 1914. *D. fullawayi* appears to be very efficient in parasitizing larvæ in coffee cherries in Honolulu, and bids fair to outstrip the earlier introduced *O. humilis*. From larvæ reared from one lot of kamani nuts all four parasites are reared. From the general observations of the writers, it would appear that *T. giffardi* may prove a most valuable parasite in supplementing the good done by *humilis, tryoni,* and *fullawayi*. While all four species of parasites attack only the medium and well grown larvæ, *humilis, tryoni* and *fullawayi* are most active in parasitizing the mature larva while the host fruits are still attached to the trees. Although Mr. E. M. Ehrhorn has observed one specimen of *O. humilis* hovering over fallen Strawberry Guavas (*Psidium cattleyanum*), the writers have never observed *humilis, tryoni* or *fullawayi* attempting to oviposit in larvæ within fallen fruits. On the other hand, specimens of *T. giffardi* have been taken from the channels in the pulp of well decayed kamani nuts made by fruit-fly larvæ, and observations in the laboratory have proved that the adult female *Tetrastichus* will enter kamani nuts through breaks in the pulp and attack larvæ. As many as seventeen punctures have been counted in a single larvæ from which were dissected forty-one Tetrastichus eggs. Laboratory data have shown that the heaviest parasitism, especially during the warmer seasons of the year, when larval development and emergence is rapid, is to be found among the larvæ emerging during the first one or two days after the host fruits have been gathered. Since *humilis, tryoni* and *fullawayi* do not oviposit, or at most but slightly, in larvæ in fallen fruits, while *Tetrastichus* does to a much greater extent, it is to be expected that *giffardi* will be able to parasitize, as they become mature, those larvæ that were either unhatched or very young when the host fruit fell from the tree. In this connection, it is interesting to note that the highest percentages of parasitism due to *Tetrastichus* are shown in Table II, developing among larvæ bred from kamani nuts—a fruit always gathered from the ground.

TABLE II. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN KAMANI NUTS (*Terminalia catappa*) GROWING IN HONOLULU, T. H.

Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism				
			Opius humilis	Diachasma		Tetrastichus giffardi	Total
				tryoni	full-awayi		
1112 9th Ave.	9/27-10/4	15	6.6	—	—	—	6.6
Waialai Road.	10/8 - 13	58	—	—	—	—	0.0
Ainahau.	10/22- 25	22	9.1	—	4.6	—	13.7
Ainahau.	10/29-11/1	176	12.0	—	—	—	12.0
Moana Hotel.	11/27- 29	32	3.1	—	—	—	3.1
317 Richard St.	9/25-10/1	4	100.0	—	—	—	100.0
317 Richard St.	10/8 - 11	16	43.7	—	—	6.3	50.0
"	10/11- 13	37	32.4	2.6	—	—	35.0
317 Richard St.	10/12- 15	22	31.8	—	—	4.5	36.3
"	10/15- 18	12	8.4	—	8.4	—	16.8
317 Richard St.	10/15- 18	42	43.	—	—	4.7	47.7
"	10/18- 20	132	30.	1.5	—	—	31.5
317 Richard St.	10/16- 18	26	80.8	3.9	—	7.7	92.4
"	10/18- 20	71	63.4	4.2	—	4.2	71.8
317 Richard St.	10/19- 22	31	54.8	—	—	3.2	58.0
317 Richard St.	10/23- 25	71	74.6	—	—	7.0	81.6
Lunalilo and Piikoi St.	9/28-10/1	109	53.3	—	—	—	53.3
1327 Piikoi St.	10/2 - 6	53	24.5	—	—	—	24.5
1327 Piikoi St.	10/15- 18	61	62.3	—	—	—	62.3
1327 Piikoi St.	10/30-11/1	82	82.6	4.9	1.7	1.7	90.9
"	11/1 - 3	106	70.	6.6	—	—	76.6
Auld Lane.	10/14- 18	24	66.7	—	—	—	66.7
Pawaa Junction.	9/30-10/2	19	—	—	—	15.8	15.8
"	10/2 - 4	38	5.2	—	—	5.3	10.5
Pawaa Junction.	10/8 - 11	10	—	—	—	40.0	40.0
Pawaa Junction.	10/16- 25	120	0.8	—	—	—	0.8
Union St.	10/29-11/1	115	48.7	—	—	1.7	50.4
Queens Hospital.	9/28-10/1	65	53.7	—	—	—	53.7
Queens Hospital.	9/30-10/4	163	39.2	1.2	—	11.7	52.1
"	10/4 - 6	143	19.6	7.0		0.7	27.3
"	10/11- 13	7	—	—	—	14.3	14.3
Queens Hospital.	10/5 - 6	8	13.	50.0	—	12.0	75.0
"	10/6 - 11	98	31.6	36.7	—	3.1	71.4
Queens Hospital.	10/12- 15	19	47.4	5.3	—	—	52.7
"	10/15- 18	8	25.0	—	—	12.5	37.5
Capitol Gardens.	9/28-10/1	11	45.5	—	—	—	45.5
Nuuana Cemetery.	9/29-10/2	4	—	—	—	—	0.0
2030 Nuuanu St.	9/30-10/4	3	33.3	—	—	—	33.3
2425 Nuuanu St.	10/12- 15	5	60.0	20.0	—	—	80.0
2425 Nuuanu St.	10/20- 22	131	30.6	4.9	—	—	35.5
Judd and Liliha St.	10/14- 18	5	20.0	—	—	—	20.0
467 Judd St.	9/30-10/11	50	—	—	—	—	0.0
467 Judd St.	10/12- 22	76	—	—	—	—	0.0
467 Judd St.	10/14- 25	369	0.3	—	—	—	0.3
601 Judd St.	9/30-10/4	23	—	—	—	4.3	4.3
601 Judd St.	10/14- 25	16	—	—	—	—	0.0
Queen Emma Park.	9/29-10/4	114	1.7	—	—	—	1.7
Queen Emma Park.	10/8 -10/13	187	0.5	—	—	—	0.5
Upper Nuuana.	10/15- 17	7	0	14.3	—	—	14.3

TABLE III. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN VARIOUS HOST FRUITS GROWN IN HONOLULU, T. H.

Host Fruits	Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism				
				Opius humilis	Diachasma		Tetrastichus giffardi	Total
					tryoni	fullawayi		
Eugenia[1]	St. Clements Ch.	9/30–10/4	9	22.2	—	—	—	22.2
"	"	10/4 – 8	54	1.8	—	3.6	5.5	10.9
"	Ainahou	9/29–10/4	16	6.2	—	—	—	6.2
Carambola[2]	1560 Beretania	9/28–10/1	3	33.3	—	—	—	33.3
Strawberry Guava	1804 College St.	9/30–10/4	14	42.9	—	—	—	42.9
"	Queen Emma Pk.	9/29–10/11	10	—	—	—	—	0.0
Mimusops elengi	Queens Hospital	10/23– 25	47	8.5	—	4.3	—	12.8
Natal Plum[4]	1814 Ahuula	10/20– 22	84	23.8	—	—	—	23.8
"	1814 Ahuula	10/26– 27	55	22.0	—	—	—	22.0
Hog Plum[5]	601, Judd St.	10/14–10/25	16	6.2	—	—	—	6.2
Lemon Guava[6]	1112 9th St.	10/21– 23	14	—	—	—	—	0.0
"	"	10/23– 25	71	8.4	—	4.2	—	12.6
	"	10/25– 29	382	5.2	—	—	—	5.2
	"	10/29–11/1	95	—	1.1	—	—	1.1
Chinese Oranges[7]	Punahou	9/28–10/1	44	4.5	—	—	—	4.5
	Punahou	10/2 – 4	8	50.	—	—	—	50.
	Punahou	10/11– 13	5	40.	—	—	—	40.
	Punahou	10/16– 18	10	40.	—	—	—	40.
	Punahou	10/19– 22	4	50.	—	—	—	50.
	Punahou	10/13– 15	7	—	29.6	—	—	29.6
	1427 Alexander	10/14– 18	18	17.9	—	—	—	17.9
	"	10/19– 22	16	25.	—	—	—	25.
	Ahua Lane	9/29–10/4	35	11.4	—	—	—	11.4
	248 Makee St.	9/29–10/1	22	36.4	—	—	—	36.4
	Kaneloa Lane	10/7 – 18	40	2.5	—	—	—	2.5
	Pauoa Valley	10/21– 25	12	33.3	—	—	—	33.3
Coffee[8]	Upper Manoa	10/13– 15	22	22.8	—	63.6	—	86.4
	"	10/15– 20	16	6.2	12.4	—	—	18.6
	1527 Makiki St.	9/30–10/6	3	33.3	—	—	—	33.3
	"	10/6 – 11	59	1.7	1.7	—	—	3.4
	1578 Luso St.	10/12– 6	195	35.9	—	18.0	—	53.9
	1578 Luso St.	10/21– 23	37	78.4	—	16.2	—	94.6
	Pauoa Valley	10/2 – 4	67	50.0	—	—	—	50.0
	"	10/4 – 6	140	2.1	—	1.5	—	3.6
	Pauoa Valley	10/21– 23	27	11.1	—	78.0	—	89.1
	"	10/23– 25	102	16.6	—	69.6	—	86.2
	Queens Hospital	10/26– 27	11	27.2	—	36.3	—	63.5
	Washington Pl.	10/26– 29	21	62.0	—	38.0	—	100.0

[1] *Eugenia michelii.* [2] *Averrhoa carambola.* [3] *Psidium cattleyanum.* [4] *Bunchosia sp.*
[5] *Spondias lutea.* [6] *Psidium guayava.* [7] *Citrus japonica.* [8] *Coffea arabica.*

While it is far too early to draw any conclusions regarding the ultimate effectiveness of these introduced parasites, data for 1914 and 1915 show that all four parasites have successfully established themselves, and are already promising much as a factor in the control of Hawaii's worst fruit pest, and form a basis for the study of the relationship between the parasites in their struggle for existence during the years to come.

SOME GRASS-FEEDING MEALY-BUGS (COCCIDÆ)

By T. D. A. COCKERELL, *University of Colorado*

I am indebted to Mr. P. H. Timberlake for some beautiful mounts of certain grass-feeding mealy-bugs, which he wishes to mention by name in an account of the parasites raised from them. They prove to belong to the group of *Pseudococcus neomexicanus* (Tinsley), but to differ from any previously described.

Pseudococcus timberlakei n. sp.

FEMALE. Body elongate, 2,016 microns long and 800 broad, as mounted; scattered hairs and many small round glands, but no lateral patches of bristles; caudal region with many glands, of two sizes, large and ring-like, and small with a distinctly cylindrical form; antennæ wide apart (167 microns), 8-jointed; labium 112 microns long and 72 broad at base; legs with long hairs, on under side of middle femur are seven long hairs (75 microns), in two rows; no denticle on claw; anal ring with six bristles, 145 microns long; long bristles of caudal lobes about 195 microns. The following measurements are in microns: middle leg, femur with trochanter, 250; tibia, 187; tarsus (without claw), 80. Antennal joints: (1) 45–47, (2) 50, (3) 42, (4) 32–35, (5) 35–40, (6) 32–35, (7) 37, (8) 80.

Mr. Timberlake's field notes are as follows:

"On salt marsh grass, Millbrae, California (near San Francisco), Oct. 14, 1915. Half-grown specimens or larger were found in exposed situations on blades or at axils of the blades, and females with egg-masses on the same parts of the plant. The lateral and caudal secretions of the active females closely resemble those of *Pseudococcus citrophilus* Clausen figured on p. 20, Calif. Exp. Station Bull. 258. (I made comparison with figure given as soon as I got back from the field.) The egg-mass or sac is rather compactly matted, about 4 mm. long and 1.5 in diameter, and the exhausted female lies exposed at one end."

The antennæ agree with those of *P. neomexicanus*, but the other characters are distinctive. The species is easily known from *P. salinus* Ckll. (which may be found in quantity on grass at the edge of the low cliff at the Scripps Institution at La Jolla, California) by the much longer bristles of anal ring and caudal bristles, as well as by the shorter first three antennal joints.

Mr. Timberlake sent for comparison a slide marked "*Pseudococcus smithii* (Essig), on *Elymus*, Ventura, Calif., Oct. 20, 1914 (C. P. Clausen)." This is said to be the species described from examples with 7-jointed antennæ as *Ripersia smithii* Essig; Mr. Clausen found that a considerable proportion of the specimens had 7-jointed antennæ, but 8-jointed specimens were not rare. The insect is a true *Pseudococ-*

cus, but very distinct from *P. timberlakei*, especially in the character of the antennæ. The following measurements in microns are from the specimen sent to me: hind tibia, 375; hind tarsus (without claw) 117; hairs of anal ring, about 125; long caudal bristles about 180; antennal joints, (1) 80, (2) 80, (3) 60, (4) 57, (5) 62, (6) 55, (7) 47, (8) 107. This is certainly not *salinus;* it appears to be related to *P. maritimus* (Ehrhorn).

Pseudococcus neomexicanus var. *utahensis* n. var.

FEMALE. Length 4.5 mm., width 2 mm ; claws without denticle, all the digitules slender. Agrees in general with *neomexicanus*, but third antennal joint *much* shorter than second, and equal with 4, 5 and 6. The following measurements are in microns: hairs of anal ring about 107; long caudal bristles about 150; middle leg, femur with trochanter, 195; tibia, 160, tarsus (without claw), 75; width of femur, 40; antennal joints, (1) 42, (2) 42-45, (3) 25, (4) 25-27, (5) 25-27, (6) 25, (7) 35, (8) 72. Collected Sept. 3, 1915.

Mr. Timberlake's field notes are as follows:

"On *Elymus*. Salt Lake City, Utah. This species was first noticed by me about the middle of July, but no collection was made until Aug. 14. Other collections were made Sept. 3, Sept. 20 and Nov. 23. All the larger specimens were found concealed between the sheaths and the stem, and hence they could not be observed in an undisturbed condition. Apparently when the females reached a fairly large size (about half grown) they became enclosed in rather thin cottony sacs of rather close texture. A female that was removed from its situs and placed in a vial, soon entirely enclosed itself in a cilindrical cottony mass about 6 mm. long and 2 mm. in diameter. This sac was apparently much more abundantly developed and certainly considerably more fluffy than in specimens taken from the stems. Those in stems were of course much flattened and the cottony secretion pressed together. A female with egg-mass of 103 eggs, collected on Nov. 23, was found at one end of sac, and not covered up, at least when leaf-sheath was torn away; neither were the eggs entirely covered up, but the cottony fibers being sticky (but not viscid) tenaciously held the eggs in place. The body coloration was not noted, certainly not striking, and if I remember right pale yellowish. The females removed from their sacs were covered with a thin white meal, and nearly destitute of the usual lateral and caudal secretions. The exhausted female found on Nov. 23 turned dull, dark, crimson-brown when boiled in KOH. The egg was described as pale yellowish-brown, darker at one end, about .4 mm. long by .2 mm. diameter."

True *P. neomexicanus*, common in northern New Mexico, lives underground on roots of grass, and is tended by *Lasius*.

Scientific Notes

New Jersey Mosquito Association Meets. This organization, which has for its object the elimination of the mosquito from the standpoint of human comfort and the attendant property values, held its third annual meeting on the 17th and 18th of February. As might be expected from its purpose the membership is composed of business and professional men of all sorts. To become a member it is merely necessary to inform the proper persons that one wishes to become connected with the movement. No dues or assessments are levied upon the individual members and the necessary expenses are borne by the organizations which belong to it.

The program of this meeting included five speakers, who were professionally connected with the practical work; eleven, who were identified with it as members of directing boards; two who were responsible for the state work and the correlation of the work of the county units; three who represented the taxpayers who receive the benefits and pay the bills; one, who represented the Interstate Anti-mosquito Committee; and one, who represented the mosquito work of the country as a whole.

One member of the first group, Mr. James E. Brooks, showed that dikes, tide gates, and trenching, drain shut-in areas of salt marsh, which the ordinary trenching will not protect, in such a fashion that no serious emergence of mosquitoes takes place. Another member, Mr. William Delaney, pointed out that pumps are necessary on certain enclosed marshes that have shrunken below the sea level, and that a twelve-inch, low-head, motor-driven, centrifugal pump with necessary trenching removed the water from 800 acres of bad breeding marsh in such a fashion that no serious emergence could occur.

Another member of this group, Mr. Harold I. Eaton, showed that the average acre cost of salt marsh trenching for 12,000 acres drained in the last three years was $4, and that the price exclusive of administration expense had been reduced from $5.22 in 1913 to $2.75 in 1915. Another member, Mr. Russell W. Gies, showed that the average per capita cost of county-wide mosquito control work was about 12 cents. Another, Mr. John Dobbins, pointed out the methods, which four years' experience in the practical work had proven to be best for fresh water mosquito control.

The members of the second group, Dr. William Edgar Darnall, Mr. E. B. Walden, Mr. Joseph Camp, Mr. Spencer Miller, Dr. H. H. Brinkerhoff, Mr. Charles Deshler, Mr. Ira Barrows, Mr. Walter Hudson, Mr. Robert F. Engle and Mr. Louis J. Richards, confined their statements to the status of the practical work in the counties which they represented.

The first member of the third group, Dr. Jacob G. Lipman, pointed out the tremendous agricultural and urban development which awaits the satisfactory control of the mosquito pest. The second, Dr. Thomas J. Headlee, pointed out the various problems of the New Jersey mosquito's natural history and control that have been recently solved and some of those which still await solution.

The members of the fourth group, Mr. Thomas Mathias, Mr. E. Morgan Barradale, and Mr. John N. Cady, devoted their attention to the results of the work (which they said were good) and the esteem (which they said was high) in which it is held by those who pay the bills.

Dr. Haven Emerson, commissioner of health for New York City, and member of the fifth group, outlined the work of this committee as one of correlating the mosquito control work of Connecticut, New Jersey and New York.

Dr. L. O. Howard discouraged the use of bats as a means of mosquito control in New Jersey on the ground that natural conditions did not favor the attempt. He set forth the work of King connecting *Anopheles punctipennis* Say. with the carriage of malaria and gave a brief account of the Bureau's work against the malarial mosquito in the lower Mississippi valley.

The following officers were elected for the ensuing year: President, William Edgar Darnall, M. D., Atlantic City; first vice-president, H. H. Brinkerhoff, M. D., Jersey City; second vice-president, Robert F. Engle, Beach Haven; secretary-treasurer, Thomas J. Headlee, Ph.D., New Brunswick.

The proceedings will be published.

Conference of Officials Engaged in Gipsy Moth Work. A conference of Officials Engaged in Gipsy Moth Work was held in Boston on February 15, 1916. Dr. L. O. Howard, chief of the Bureau of Entomology, presided and the following officials and visitors were present.

Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, Canada.
Mr. John D. Tothill, Field Officer, Entomological Branch, Fredricton, N. B.
Mr. L. S. McLaine, Field Officer, Entomological Branch, Fredricton, N. B.
Mr. G. E. Sanders, Field Officer, Entomological Branch, Annapolis Royal, N. S.
Mr. E. J. Cadey, Special Agent, in Charge of Gipsy Moth Work, Portland, Me.
Prof. W. C. O'Kane, Deputy Commissioner, In Charge of Moth Work, Durham, N. H.
Mr. W. O. Osgood, Assistant in Gipsy Moth Work, Durham, N. H.
Mr. H. L. Bailey, In Charge of Suppression of Insect Pests, Bradford, Vt.
Dr. H. T. Fernald, State Inspector of Nurseries, Amherst, Mass.
Mr. R. H. Allen, Assistant Inspector of Nurseries, Boston, Mass.
Mr. C. O. Bailey, Secretary, Massachusetts State Forester, Boston, Mass.
Mr. George A. Smith, Assistant, Massachusetts State Forester, Boston, Mass.
Mr. Paul D. Kneeland, Assistant, Massachusetts State Forester, Boston, Mass.
Mr. Harry B. Ramsey, District Moth Superintendent, Worcester, Mass.
Mr. Harold L. Neale, City Forester, Worcester, Mass.
Mr. Allen Chamberlain, Massachusetts Forestry Association, Boston, Mass.
Mr. Harry Horovitz, Assistant Entomologist, Providence, R. I.
Mr. I. W. Davis, Assistant Entomologist, New Haven, Conn.
Dr. G. G. Atwood, Chief, Bureau of Horticulture, Albany, N. Y.
Mr. Harry B. Weiss, Assistant Entomologist, New Brunswick, N. J.
Mr. E. R. Sasscer, Chief Inspector, Federal Horticultural Board, Washington, D. C.
Mr. R. I. Smith, Quarantine Inspector, Federal Horticultural Board, Boston, Mass.

The following assistants of the Bureau of Entomology, engaged on Gipsy Moth Investigations, were also present: A. F. Burgess, J. W. Chapman, G. E. Clement, C. W. Collins, S. S. Crossman, R. W. Glaser, H. L. McIntyre, C. W. Minott, Willis Munro, D. M. Rogers, C. W. Stockwell, J. N. Summers and L. H. Worthley.

The meeting was called for the purpose of conferring on gipsy moth and brown-tail moth problems and reports were given as to moth conditions in each state and the Dominion of Canada.

The morning session was occupied with these reports and their discussion.

In the afternoon reports were made by different members of the Federal force. A report was given on each line of work and a general discussion followed. Those who attended expressed the opinion that much benefit had been secured at the conference. An invitation was presented to those who attended as well as to a number of states that were not fully represented, to inspect the field work early in July.

In the evening many of those who attended the conference were present at the regular meeting of the Cambridge Entomological Club. After the regular program of the club had been completed, interesting remarks were made by Doctor Howard, Doctor Hewitt, Doctor Wheeler, Doctor Fernald, and Doctor Johnson.

On Thursday morning a number of the officials took advantage of the opportunity to visit the Gipsy Moth Laboratory at Melrose Highlands, Mass., and inspect the work which was being carried on there and examine the equipment and apparatus which is used in the field work.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The recent proof[1] that *Anopheles punctipennis* Say. is a host of tertian malaria is of great interest and importance. For some sixteen years, it has been known that another species, *Anopheles quadrimaculatus* Say., was able to transmit this disease through its bites, and though *punctipennis* has always been suspected, most of the experiments gave only negative results. Mr. King has now caught the criminal "with the goods." In Connecticut, at least, where both species occur, *A. punctipennis* is far more common than *A. quadrimaculatus*, as evidenced by the adults reared from *Anopheles* larvæ, and this discovery readily explains the prevalence of malaria in sections where it is extremely difficult to find *A. quadrimaculatus*. Now that it has been shown that *punctipennis* is also guilty, the very abundance of this species ought to stimulate the people to take active measures for its suppression in nearly every locality.

W. E. B.

The appearance in the past few months of three volumes, each different, though excellent in its way, on the honey bee, augers an increased interest in this ancient friend of man and should eventuate in many additional apiaries, especially small ones, throughout the country. Much has been written lately on the conservation of natural resources, mostly by those who know little of the honey bee and its possibilities.

[1] W. V. King, American Journal of Tropical Diseases and Preventive Medicine, Vol. III, page 426, February, 1916.

There should be a few to a number of hives on every farm. The returns from each would not be large and yet the value of the aggregate production would amount to an enormous sum. This type of conservation requires no preliminary legislation, simply a little individual initiative. The section of Apiary Inspection has already done much to popularize bee-keeping and entomologists generally will find it decidedly advantageous to give due emphasis to this phase of their work.

Reviews

Productive Bee-keeping, Modern Methods of Production and Marketing of Honey by FRANK C. PELLETT, pp. i–xiv, 1–302, 134 text figures, 1916. J. B., Lippincott Company, Philadelphia and London. $1.50 net.

This attractive addition to Lippincott's Farm Manuals abounds in excellent illustrations and is evidently written by one in love with his work. The subject-matter is presented in an admirable manner, the author at the outset dwelling upon the friendly relations which should exist between the bee-keeper and his charges, and incidentally commends them to the attention of the nature-lover.

The business opportunities are discussed in a somewhat conservative though optimistic manner and there is no doubt but that the country would be materially benefited if bee-keeping was more general. The beginner will find in this work commonsense suggestions for starting and managing an apiary, all phases being considered from the location of the apiary to the removing and marketing of the honey. There is a full discussion of bee diseases, an interesting chapter on laws that concern the bee-keeper and at the end of each chapter a number of questions, evidently designed to facilitate the use of the volume as a text-book. Both amateur and professional will find much of interest and value in this addition to the long series of bee books (*Advertisement*).

The Ecological Society of America. A meeting of ecologists was held at Columbus in Convocation Week to take action upon the proposal made at the Philadelphia Meeting for the formation of a society of ecologists. Over fifty persons were present and the Organization Committee held letters from about fifty others who expressed interest in the project. In view of these facts it was unanimously voted to organize under the name, The Ecological Society of America. It was decided to enroll as charter members not only those present at the organization, but also those who had by letter expressed a desire to be included in the membership, as well as those joining prior to April 1, 1916. A constitution which had been drafted by the Organization Committee was adopted, and the following officers were elected: President, Prof. V. E. Shelford, of the University of Illinois; vice-president, Prof. W. M. Wheeler, of Harvard University; secretary-treasurer, Dr. Forrest Shreve, of the Desert Laboratory. The first regular annual meeting will be held in New York during the next Convocation Week, where a program will be arranged in harmony with the programs of other societies, so as to minimize serious conflict. Frequent field meetings will be held under the auspices of the society,—four having already been arranged for the coming summer. Several proposals for the carrying out of coöperative investigations are also being entertained by the members of the society.

Current Notes

Mr. W. V. King, Bureau of Entomology, stationed at New Orleans, attended a conference at Washington on January 3.

Mr. A. H. Jennings, Bureau of Entomology, was on furlough for the months of December, January and February, on account of ill health.

Mr. T. E. Holloway, Bureau of Entomology, in charge of the laboratory at New Orleans, was in Washington during the month of February.

The following agents of the Bureau of Entomology were in Washington for conference during the month: F. C. Bishopp, A. C. Morgan, E. A. McGregor, B. R. Coad, G. L. Garrison and T. F. McGehee.

Mr. A. W. Yates, apiary inspector of Hartford, Conn., has been engaged to give a course in beekeeping at the Connecticut Agricultural College at Storrs.

Mr. L. P. Rockwood, Bureau of Entomology, whose address was originally Room 416, Vermont Building, Salt Lake City, Utah, has removed to Forest Grove, Ore.

Mr. E. L. Barrett, Bureau of Entomology, has been transferred from the Pasadena, Cal., laboratory to assist Mr. E. G. Kelly at the Wellington, Kan., Field Laboratory.

Dr. L. O. Howard planned to visit the field stations located at Orlando and Gainesville, Fla., Thomasville, Ga., and Columbia, S. C., during the early part of March.

Mr. L. G. Gentner, formerly of the Branch Experiment Station at Medford, Ore., is now a member of the Department of Entomology, University of Wisconsin, Madison, Wis.

Dr. Julius Nelson, Professor of Biology at Rutgers College since 1888, died from an attack of pneumonia at his home in New Brunswick, February 16, aged 58.

Prof. H. A. Surface, Economic Zoölogist of Pennsylvania, gave four lectures on wild animal life before the students of the Yale Forest School the latter part of February.

Prof. S. W. Williston has recently been elected a fellow of the American Academy of Arts and Sciences, and a correspondent of the Academy of Natural Sciences of Philadelphia.

Mr. C. K. Wildermuth, Bureau of Entomology, recently attached to the staff at the Maxwell, N. M., field station, has resigned in order to continue his studies.

Mr. Daniel G. Tower, Bureau of Entomology, recently located at the West Lafayette, Ind., field station, has been transferred to the office of Tropical and Subtropical Fruit Investigations.

Dr. E. F. Phillips, Bureau of Entomology, attended the annual convention of the National Beekeepers' Association at Chicago, Ill., February 22–24. Prof. Francis Jager was elected president.

The Nashville, Tenn., Field Laboratory, Bureau of Entomology, was moved to Knoxville, Tenn., about March 1, 1916. The present staff at Nashville was transferred to the Knoxville Station.

Professor G. M. Bentley, State Entomologist of Tennessee, with headquarters at Knoxville, is Secretary-Treasurer of the Tennessee Florists' Association.

Mr. C. W. Creel, of the Forest Grove, Ore., field station, Bureau of Entomology, was in Washington during the month of January.

Mr. T. D. Urbahns of the Pasadena, Cal., field laboratory, Bureau of Entomology, visited Washington during the month of January for the first time in several years.

Mr. F. C. Bishopp, Bureau of Entomology, in charge of the laboratory at Dallas, Texas, underwent a serious operation at that place during February. His condition is greatly improved.

Dr. Charles H. T. Townsend of the Bureau of Entomology gave an illustrated lecture on Verruga before the students of the medical school of Howard University, Washington, D. C., January 15.

Mr. G. G. Ainslie of the Nashville, Tenn., field laboratory, Bureau of Entomology, visited Washington during the early portion of January for the purpose of consultation and preparation of manuscript.

Mr. A. J. Ackerman, Bureau of Entomology, who has been working on nursery insects at West Chester, Penn., has recently visited Washington in connection with the preparation of his field notes.

Mr. E. W. Geyer, Bureau of Entomology, who has been in Washington preparing manuscript on the biology of the codling moth in New Mexico, has returned to his field station at Roswell.

According to *Science*, it is planned to erect a monument on the Roman Campagna in memory of Prof. Angelo Celli, who made important investigations there regarding malaria and its transmission by mosquitoes.

According to *Science*, Mr. C. A. McLendon, formerly field pathologist of the South Carolina Agricultural Experiment Station, has accepted a position as expert in cotton breeding with the Georgia State Board of Entomology, Atlanta, Ga.

Mr. C. M. Packard, Bureau of Entomology, formerly attached to the staff at the Wellington, Kan., Field Laboratory, has been transferred and detailed to assist Mr. T. D. Urbahns at the Pasadena, Cal., Field Laboratory.

Mr. George S. Demuth, Bureau of Entomology, attended the annual meeting of the Kentucky Beekeepers' Association at Lexington, January 5, and of the New Jersey Beekeepers' Association at New Brunswick, February 10–11.

According to *Science*, Prof. V. L. Kellogg, who has been serving as a director of the Belgium Relief Commission in Brussels for the past eight months, has returned to take up his work at Stanford University.

Dr. W. J. Holland, director of the Carnegie Museum, gave the principal address at the formal opening of Alden Hall of Biology at Allegheny College, February 4. His subject was "Biology a Cultural and Practical Study."

Prof. Stephen Alfred Forbes, of the University of Illinois, and Prof. Samuel Wendell Williston, of the University of Chicago, were elected honorary fellows of the Entomological Society of America at its meeting at Columbus, Ohio.

Mr. C. N. Ainslie of the Elk Point, S. D., field laboratory, Bureau of Entomology, visited Washington during the winter for the first time in seven years, for the purpose of consultation and the preparation of manuscript.

Mr. A. I. Fabis, Bureau of Entomology, has returned to his field station at Monticello, Fla., after spending some time in Washington. He will resume his duties at Monticello, assisting Mr. Gill in pecan-insect investigations.

The following were among the visitors at the Bureau of Entomology, Washington, D. C., during December: Wilmon Newell, Plant Commissioner of Florida; J. T. Crawley, Director of the Cuban Experiment Station; A. H. Rosenfeld, Director of the Tucuman Experiment Station, and Prof. C. T. Brues, of Bussey Institution.

According to *Science*, Dr. L. O. Howard, Chief of the Bureau of Entomology of the U. S. Department of Agriculture, will give the evening lecture at the general meeting of the American Philosophical Society on the evening of April 14. The subject will be, "On Some Disease-bearing Insects."

Mr. H. G. Ingerson, Bureau of Entomology, who has been assisting Mr. F. L. Simanton at Benton Harbor, Mich., in orchard insecticide investigations, has been in Washington for the purpose of preparing notes on the subject of his field investigations and library work.

Mr. W. D. Hunter, Bureau of Entomology, in company with G. B. Sudworth of the Forest Service, both members of the Federal Horticultural Board, visited Boston during the month of January in connection with the preparations for the fumigation of all foreign cottons arriving in the United States after February 1.

Mr. E. G. Carr, State Apiary Inspector of New Jersey, has recently been employed by the Bureau of Entomology to make a survey of the present conditions and possibilities of beekeeping in the state of North Carolina. He finds the outlook most promising and spent the month of January in Washington making out reports on this line of work.

Mr. C. M. Packard, recently attached to the staff at the Wellington, Kan., field laboratory, Bureau of Entomology, was in Washington during a portion of the month of January. Mr. Packard has in preparation a paper dealing with the biology of several parasites of the Hessian fly.

Mr. F. L. Simanton, Bureau of Entomology, who has been engaged in investigations of orchard insecticides and spraying machinery, with headquarters at Benton Harbor, Mich., visited Washington recently for the purpose of summarizing notes on the subject of his field investigations, preparation of manuscripts and library work.

A letter written by A. W. J. Pomeroy from Kamerun, West Africa, on November 7, 1915, reached Washington on March 2. Mr. Pomeroy is now a lieutenant in the West African Frontier Force. He has been ill with some tropical fever but at the time of writing was on active duty.

A course of fifteen public lectures on tropical medicine is being given Saturday mornings at the University of California. Dr. E. L. Walker gives five of these lectures and his subject for April 15 is "Parasitic Insects and the Rôle of Insects in the Transmission of Tropical Diseases."

Dr. E. F. Phillips, Bureau of Entomology, attended ten conventions of beekeepers in the Middle West during November and December, these being arranged in a

circuit for the convenience of those outside the various states who desired to attend. The meeting at Grand Rapids, Mich., was the fiftieth annual convention of Michigan beekeepers.

The onion thrips, according to Mr. M. M. High, Bureau of Entomology, is about as abundant as usual in south Texas, more so than in the previous year, and he is of the opinion that it will increase in numbers unless checked. The growers generally are handling the proposition very well, especially at Mission, Texas.

Prof. Herbert Osborn was given a dinner at the Chittenden Hotel, Columbus, Ohio, December 29, 1915, by about forty of his former students. The guest of honor was presented with some verses entitled "Herbert Osborn, an Appreciation," by J. G. Sanders, and the signatures of the other students, on vellum, appropriately illuminated in black, red and gold.

A course of twelve lectures was given in February, March and April by members of the Staff of the New York State Museum, in the Education Building, Albany, N. Y. This course included two lectures dealing with insects,—"Man and Insects" by Dr. E. P. Felt, and "Harmonics and Cross Purposes in the Insect World" by F. T. Hartman.

At the annual meeting of the Brooklyn Entomological Society, held on January 13, the following officers were elected for 1916: President, W. J. Davis; vice-president, W. T. Bather; treasurer, Chris. E. Olsen; recording secretary, J. R. de la Torre Bueno; corresponding secretary, R. P. Dow; librarian, A. C. Weeks; curator, George Franck; publication committee, C. Schaeffer, R. P. Dow, and the recording secretary, *ex-officio*.

Mr. E. G. Smyth, from the office of the Commissioner of Agriculture at Rio Piedras, Porto Rico, recently visited Washington for consultation in regard to co-operative work in Porto Rico on insects which occur on that island as well as in the Gulf region.

Mr. D. E. Fink, Bureau of Entomology, visited Washington during January. He is engaged in making a special study of cucurbitaceous insects and their rôle as transmitters of the virus of wilts and mosaic diseases. He has also conducted similar studies on the springtails, the spinach aphis, and other truck crop insects which have been injurious during the past year at Norfolk, Va.

Mr. A. B. Champlain, Bureau of Entomology, stationed at Lyme, Conn., left Washington on January 24 after several days of consultation and study of literature and collections. On his return trip he stopped at Huntington, L. I., and assisted Mr. Griffith in the study of the insects in connection with the demonstration control against the hickory bark beetle and two-lined chestnut borer.

The Ohio State University has recently inaugurated a plan providing for Research Professors which enables the holders to devote their time especially to research work and Professor Herbert Osborn has been elected Research Professor in the Department of Zoölogy and Entomology. He will be relieved from routine, class and department duties, devoting his time to research, especially in the line of Entomology, but will continue to have direction of research work of Graduate students in his particular field.

A recent inspection by Mr. T. E. Snyder of the experimental and demonstration control project in the White Top Purchase Area, Tennessee and Virginia, conducted

by the Forest Service under the advice and instructions of Dr. A. D. Hopkins, shows that there is every indication from the relative number of black tops, brown tops and newly infested trees, that there is a marked decrease in the infestation and that a destructive invasion has been checked.

Dr. Donaldson Bodine, professor of geology and zoölogy at Wabash College, died recently at forty-nine years of age. Doctor Bodine graduated from Cornell University in the Class of 1887, and received the degree of Doctor of Science from his alma mater in 1895. While pursuing graduate studies at Cornell he did considerable work on the histology and taxonomy of insects—especially Lepidoptera. For several years Doctor Bodine has been dean of the faculty at Wabash.

The annual meeting of Entomological Workers in Ohio State Institutions was held in Room 100, Botany and Zoölogy Building, Ohio State University, Columbus, Ohio, Tuesday, February 1, 1916. This meeting was open to the public and the following program was carried out:

Present Problems of Inspection Work, by N. E. Shaw.

General Reports from Heads of Department Organizations, by H. A. Gossard, N. E. Shaw, and Herbert Osborn.

Ten Minute Report by Individual Investigators:

Review of Projects. Insect Transmitters of Fire-blight, by H. A. Gossard.
Review of Projects. Photography as an Aid to Insect Study, by W. H. Goodwin.
Review of Projects. City Problems of Insect Control, by J. S. Houser.
Review of Projects. Food Records of Pentatomids, by R. D. Whitmarsh.
Review of Projects. Progress Report on Ox Warble Fly Investigations, by D. C. Mote.
Review of Projects, by J. L. King. Presented by H. A. Gossard.
Orchard Inspection, by E. J. Hoddy.
Quarantine on Christmas Trees and Greenery from Gypsy Moth Area of New England, by H. E. Evans.
Report of Control of Gypsy Moth Outbreak, by H. J. Speaker.
Apicultural Work, by James S. Hine.
Observations on Spiders of Ohio, by William M. Barrows.
Life Histories of Syrphidæ, by C. L. Metcalf.
Records of Exotic Orthoptera in Ohio, by W. J. Kostir.
Hemiptera-Heteroptera of Southeastern Ohio, by C. J. Drake.
Additional Records in Ohio Homoptera, by Herbert Osborn.

Reports on the investigation, instruction and demonstration control work carried on during the past season by the Bureau of Entomology, in connection with a study of present infestation by *Dendroctonus* beetles in the Yosemite National Park in coöperation with the Interior Department, show that the control work carried on by the Interior Department during the past three years, under recommendations of the Forest Entomologist, has resulted in bringing the infestation of the entire park under sufficient control as to require but little attention during the coming season.

At the tenth annual meeting of the Entomological Society of America, held at Columbus, Ohio, December 29 and 30, the following officers were elected: President, F. M. Webster, U. S. Bureau of Entomology; first vice-president, E. P. Felt, New York State Entomologist; second vice-president, A. L. Melander, Washington State College; secretary-treasurer, J. M. Aldrich, U. S. Bureau of Entomology, West Lafayette, Ind.; additional members of the executive committee, H. T. Fernald, Massachusetts Agricultural College; W. E. Britton, State Entomologist of Connecti-

cut: P. J. Parrott, Entomologist, New York Agricultural Experiment Station; E. D. Ball, Oregon Agricultural College; C. Gordon Hewitt, Dominion Entomologist.

The Second Pan-American Scientific Congress was held in Washington, December 27, 1915, to January 8, 1916. One of its numerous sections was entitled "Conservation of Plant Life," and under this section there was one session in which papers were presented bearing upon the general subject of quarantine, in which entomologists were interested. Mr. Marlatt, Chairman of the Federal Horticultural Board, and Dr. L. O. Howard, Chief of the Bureau of Entomology, took part in this discussion.

A community demonstration on methods of control of *Scolytus quadrispinosus* in hickory, and *Agrilus bilineatus* in oak on Long Island is being made under the specific direction of Dr. A. D. Hopkins, Bureau of Entomology; 942 infested hickories and 911 infested oaks, within an area of 1,200 acres and involving six estates, were marked during the fall for treatment. At present the control work is being carried on by owners with special energy. Both the marking and control work are under the immediate supervision of the assistant in shade tree work, Mr. L. C. Griffith.

The present regulations of the U. S. Department of Agriculture require that a copy of every manuscript intended for publication outside of the Department be submitted to the Assistant Secretary for filing in his office. It will save considerable work and time if Department agents who submit manuscripts for publication outside of the Department send in three copies, one to be filed in the office of the Assistant Secretary, one to be sent to the publishers, and the third to be filed in the Bureau with which they are connected.

It has been observed by members of the Bureau of Entomology that the cabbage looper (*Autographa brassicæ*) has different habits according to the region in which it occurs, due doubtless to climate, heat and cold, and environment. This species can be easily controlled in Tidewater, Va., but it is more difficult to destroy in the Atlantic region of the North. There is no evidence that when this species occurs in Tidewater, Va., it cannot be controlled by almost any spray since the conditions there are quite favorable for infection by a bacterial disease. The combination of the disease and poisons kills a high percentage of the larvæ.

Theodore Pergande, the oldest scientific assistant in point of continued service in the Bureau of Entomology of the U. S. Department of Agriculture, died on March 23, in Washington, at the age of seventy-six. He was born in Germany; came to America at the outbreak of the Civil War; served through the war in the northern army, and later became assistant to the late C. V. Riley when the latter was state entomologist of Missouri, coming with him to the Department of Agriculture at Washington in June, 1878. He was a keen observer of the structure and habits of insects, and was especially noted for his work on the Aphididæ.—*From Science*.

According to the *Experiment Station Record*, four new entomological laboratories were completed in Canada during the summer of 1915, located respectively at Annapolis Royal, N. S.; Fredericton, N. B.; Treesbank, Man.; and Lethbridge, Alb. The laboratory at Fredericton is the most elaborate of these structures and is a two-story and basement brick building 24 by 30 feet, located on the campus of the University of New Brunswick. Its work has been especially directed toward the natural control of insects, notably the brown-tail moth, tent caterpillar, spruce budworm, and fall webworm. The laboratory at Annapolis Royal is a wooden one-story and basement building, 26 feet square. It is located on the county school grounds and is equipped with special reference to combatting the brown-tail moth and for studies

of the bud moth, fruit worm, and other fruit pests. It replaces a former temporary laboratory at Bridgetown, which is to be used as a substation wherever most needed. The laboratories at Treesbank and Lethbridge are of the bungalow type, the former being 12 by 16, and the latter, located on the Dominion substation farm, 23 by 20 feet.

Dr. E. A. Back, of the Bureau of Entomology, has substantially completed his work in Honolulu and will shortly report to Washington to complete the general bulletin on the Mediterranean fruit fly. Mr. C. E. Pemberton will remain in Honolulu in charge of the work, assisted by Mr. Willard, who is in direct charge of the inspection and certification of export fruits in coöperation with the Federal Horticultural Board of the United States Department of Agriculture. The future development of the research work in the Hawaiian Islands in relation to the fruit fly will be determined after Doctor Back returns to Washington. Doctor Back has recently submitted to the home office a very interesting book of photographs illustrating the fruit-fly work and conditions in Hawaii. In this book are photographs of drawings of four of the introduced parasites. *Opius humilis* is the one which has hitherto been reported as being so efficient in its parasitism of larvæ, particularly on coffee plantations. Among the parasites figured, however, is a species, *Diachasma fullawayi*, more recently established, which, within a single year, has so increased that in one collection of coffee berries, 92 per cent of the larvæ were found parasitized. Further details relative to these and other parasites are given in papers already published by Doctor Back.

The work of the Bureau of Entomology on animal parasites is in direct charge of Mr. F. C. Bishopp at Dallas, Texas. At that place Messrs. H. P. Wood and E. W. Laake are located continuously, and Mr. W. E. Dove is present during the winter months. The work conducted follows a considerable number of lines, among which may be mentioned the work on the biology and control of the various ticks, ox warbles, stable fly, horn fly, and pests of poultry, including lice, mites and fleas; also on the control of flies about slaughter and packing-houses. Temporary field laboratories are established in regions where losses are most severe. One of these substations is located at Uvalde, in the semi-arid region of Texas. Mr. D. C. Parman, who is located here, devotes the major part of his time to investigations of the so-called screw worm, and to certain species of Tabanidæ which are very abundant and also concerned in the transmission of anthrax. Mr. J. D. Mitchell, with headquarters at Victoria, Texas, devotes a portion of his time to work on insects affecting live stock. Mr. W. E. Dove, during the past season, conducted investigations on the horse bots, particularly *Gastrophilus hæmorrhoidalis*, at Aberdeen, S. D. Arrangements have been made for the study of Tabanidæ, which are important pests of live stock in parts of Nevada and California, in coöperation with the experiment station of Nevada. It is possible also that other work with horseflies will be taken up in the swampy area in southeastern Texas and southern Louisiana during the coming year. It is hoped that various agents of the Bureau will assist as far as possible in this work by making notes on insects affecting animals when such occurrences come to their notice in connection with their other work. Specimens of various animal pests will also be gratefully received at the Dallas laboratory.

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